THE TELEGRAPHIC JOURNAL AND

Electrical Review.

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A GOVERNMENT INSPECTOR "IN THE DARK."

IT seems probable, as will be gathered from the report which appears in another column, that the scheme for the establishment of an electric tramway at Littlehampton will be "nipped in the bud" at a very early stage of its development. Retrograde officialism, if the report furnished to us is correct, "blocks the way." Major-General Hutchinson, R.E., the Board of Trade Inspector who was dispatched to the little Sussex watering place in order to take evidence relating to the electric tramway which, with the full sanction of the Local Board and of a large majority of the inhabitants, it is proposed to run from the railway station to the sea-front, is evidently imbued with a strong dislike of progressive science, and like most typical representatives of permanent officialism he seems to look upon the affairs of to-day as though they were happening a hundred years ago. Perhaps, like Rip Van Winkle, the gallant inspector has been indulging in a protracted period of somnolence, and this theory is rather supported by his avowal that he is "very much in the dark" regarding electricity as a motive power. But fortunately for our national prosperity other people are a trifle wider awake, and among these may be classed the promoters of the proposed Littlehampton Electric Railway. Usually a Board of Trade Inspector contents himself with hearing evidence, and it is unfortunate that General Hutchinson did not follow the same wise course, instead of venturing an assertion eminently calculated to render him ridiculous in the eyes of the scientific world. Everyone ought to know by this time, even Government inspectors, that the utility of electricity as a motive power has been thoroughly well established at Brighton, Portrush, Blackpool, Ryde, and numerous places on the Continent of Europe and in America. The only objections, therefore, which could be entertained to the proposed electric tramway are:—1. That it would be likely to cause an obstruction; 2. That it would be likely to occasion accident. Of these the inspector has himself disposed of the first, because he practically intimated that a horse tram would receive his support. As to the second objection, it is too flimsy altogether to bear investigation. Practically there is no more danger arising from an electric tramcar than from an ordinary vehicle, and because there is a possibility of one horse in a thousand being startled, it is absurd to contend that the system should be entirely tabooed. The railway service might be prohibited on equally reasonable grounds.

ON THE POLARISATION OF RESISTANCE COILS.

By ARTHUR DEARLOVE, A.S.T.E.

IN your last issue and in your number of February 4th, 1887, there appear extracts from *Science* and the *Electrical World* giving accounts of some experiments made by Mr. B. F. Thomas and R. H. E. on the above subject. These experiments were undertaken with the view of ascertaining the cause of polarisation and some suggestions are made as to a possible remedy.

I purpose, after a few remarks respecting these two communications, to give a brief account of my own experience with polarising coils and the method of treatment to which they may be subjected in order to get rid of damp and moisture—the initial cause of polarisation.

Mr. B. F. Thomas recognises that polarisation is due to the presence of moisture in the silk, and he suggests that not only should the coils be paraffined, as is usual, but that the box containing the coils might be advantageously filled with paraffin wax.

It is somewhat doubtful whether paraffin wax is so good a material for this purpose as is generally supposed.

This wax is exceedingly subject to cracks, and capillary attraction through the cracks causes moisture to be conveyed to the surface of the silk.

As this seems a well-accepted fact, it appears reasonable to suppose that the solid block of paraffin would not be an efficient protection; in fact, I have known coils so shielded polarise strongly, such coils, for instance, as those enclosed in Mr. Cromwell Varley's form of slide resistance.

With reference to the "strange phenomena" R. H. E. speaks of, I have quite failed by experiment to reproduce the effects he observed while working on this subject.

I am inclined to think that thermal currents must be responsible for the greater part of the large deflection he obtained when all the plugs of his resistance box were inserted.

It is evident that the "element" producing the current (whether thermal or electrolytic), which he records, must necessarily have an excessively small *internal* resistance, assuming, of course, that the plugs of R. H. E.'s coil box fitted even moderately well.

As a suggestion to determine whether the deflection was due to thermal or polarisation effects, let the poles of the charging cell be reversed, then, if electrolytic, the direction of the deflection will also be changed—but, if thermal, no change in direction should occur.

A thermal couple will give the results R. H. E. noticed, but with similar conditions to those he appears to have had, it is very difficult to obtain anything approaching so high a deflection, even when using a very delicate astatic galvanometer.

It is to be regretted that the resistance of the galvanometer, and that of the cell R. H. E. used, is omitted from his communication.

The cause of polarisation is, it appears to me, not far to seek; the coils of resistance bobbins are invariably "double wound," and, therefore, the spires in immediate contact are often at large differences of potential.

Assuming now, the presence of moisture, we have, on the passage of a current through the coils, a liberation of hydrogen and oxygen gases on the adjacent surfaces of the spires, thereby creating all the conditions necessary for the formation of a secondary cell.

This, on being placed in circuit with a galvanometer only, will obviously send a current through that instrument, giving the so-called "polarisation" effect.

As an example of the extent to which absorption of moisture may take place in a humid climate, there lately came under my notice a coil which had been returned from South America as defective and in need of readjustment.

The wire in this coil was paraffined in the usual way, and when sent out by the maker had a resistance of 100,000 ohms. On testing it on its return to England

its resistance was only 40,000 ohms, and it polarised immensely.

The coil was dismounted and heated in paraffin wax for an hour, the wax being at a temperature of 120° C.

When the coil had cooled down it was again tested, and found to have recovered its proper value.

Such treatment is entirely successful; but, unfortunately, it has some drawbacks, as sometimes it is inadmissible to subject valuable standards and their mountings to the requisite temperature.

Another method, which avoids these objections, and one which has been employed with success by Mr. Herbert Taylor, is to place the defective coil under the bell jar of an ordinary air pump, which jar also covers an open vessel containing sulphuric acid.

The air is exhausted and the apparatus left for, say, 12 hours, after which the coil will be free from moisture and polarisation, and its orginal resistance will be completely restored.

To ensure against absorption of moisture and resulting polarisation, it is quite practicable to construct the coils in hermetically-sealed cases, either of glass or metal, and, to my knowledge, this has been done in several instances with perfect success.

The only objection is that the construction of such a resistance box is somewhat costly.

In telegraph stations situated in moist tropical climates, it is a matter of great importance to have standards of resistance that can be thoroughly depended upon, and I believe the only satisfactory plan is to follow the method just mentioned, and hermetically seal the coils, thereby entirely avoiding the danger of polarisation and the attendant diminished resistance.

This danger, which is no imaginary one, has been known to occur, and has consequently given rise to a totally false impression as to the actual state of the insulation resistance of important cables.

LOCAL ACTION IN BATTERIES.

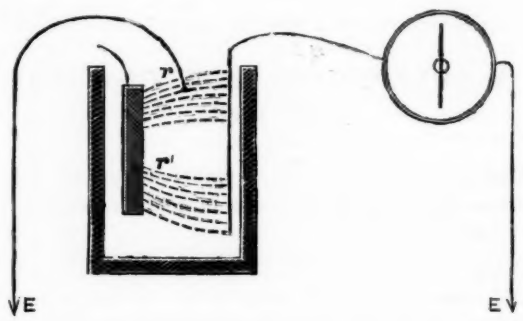
WHEN one terminal of a battery is disconnected and the other connected through a galvanometer to earth, a weak current is produced. The direction of this current is often different in direction from the current which would be produced by also putting the other electrode of the battery to earth. Sometimes the current thus produced is in the same direction from both electrodes, but sometimes in reverse directions. Moreover, the strength and direction of these currents vary from day to day. This phenomenon is more observable in old than in freshly made batteries. And the seeming irregularity in the direction of the current is easily accounted for by the local action of the battery, together with the leakage due to the solution creeping over the outside of the pots.

For instance, in the Daniell's battery the sulphate of copper solution is more dense at the bottom than at the top of the cell, so that the E.M.F. between the copper and the zinc at the bottom of the cell is greater than the E.M.F. at the top of the cell. Hence a current is produced flowing from the zinc to the copper at the bottom of the cell, and from the copper to the zinc at the top. In this action the zinc only plays a secondary part, since if it is removed the action still continues between the top and the bottom of the copper plate.

There is thus an electromotive force and a circuit within each cell. Now, if a galvanometer is connected to one of the electrodes of the cell and to earth, a current will be produced. The production of this current is illustrated by the figure, where there is a circuit between the top and the bottom of the copper plate, but owing to the creeping of the solution over the side of the cell, there is a leakage to earth from the solution of the cell, and thus a circuit is formed through the galvanometer. The position of the resultant leakage of the cell will determine the direction of the deflection of the galvanometer. Thus if the resultant leakage was at r_1 instead of r, the deflection of the galvanometer would be in the reverse direction.

If the galvanometer is connected to the zinc instead of to the copper, a current will be produced still, since a part of the circuit within the cell is still bridged over.

When a number of cells are joined in series, sometimes the positions of the resultant leakages of the cells assist in the production of a current through the galvanometer, but at other times they oppose each other.



The difference in the specific gravity of the active and the used solution of the battery is also the cause of the uneven manner in which the plates are worn away. Thus in a bichromate battery the zinc always wears away more at the top than at the bottom, but in the Daniell's battery the zinc wears away most at the bottom, and the deposit of copper in the copper plate is always thicker at the bottom than at the top of the cell.

W. MOON.

ELECTRICITY AND RAILWAY WORKING.

DUPLEXING SINGLE NEEDLES ON THE CALEDONIAN RAILWAY.

IN an article of November 26th last year, on "Electricity and railway working," we drew attention to the marked diversity displayed by railway companies in the choice of signalling apparatus for announcing trains and regulating traffic; and now we have to notice, as if by way of contrast, the marked and universal agreement there is amongst all railway telegraph engineers as to the value and suitability of the single needle for message work. In fact, it has long been recognised as being, far and away, the best instrument for railway work, on account of its durability and simplicity; both on through circuits as well as the omnibus ones, where from 15 to 20 stations are sometimes crowded upon a single circuit. To this instrument the whole of the companies are wedded, and efforts have of late been made to give it the dual character of "sound and sight" reading, and such has been the success attained that an efficient railway clerk can now take "G" from it quite as smartly as his postal *confrère* can from the more aristocratic Morse sounder.

The postal telegraph authorities anticipating a large increase of work under the sixpenny rate, increased the carrying capacity of their wires by duplexing as far as possible their existing Morse circuits; but so far as we know the single needle has never before been successfully worked as a duplex. The very marked increase of message work on the Caledonian Railway system during the tourist season last year so overburdened the wires between Carlisle and Glasgow that the question had to be faced, either to solve the problem of successfully duplexing the single needle, or run new wires for about 104 miles. So far as we are aware, Mr. A. S. Dunn, telegraph superintendent and engineer of the Caledonian Railway Company, Glasgow, is the first to have solved the question in a practical way. Differential coils were wound, rheostats made, and a trial resulted in complete success. A single needle instrument was cut in two, the bottom or handle part used for sending, whilst the top, fixed upon a specially made base, became

the receiver. But this was not all. The through circuit had two intermediate stations upon it, and these it was determined to allow to remain, with instructions, however, not to touch their own instruments, unless called up—where working singly—by either terminal station. A simple plug switch was inserted in the balancing circuit at either end in case any confusion arose or difficulty as to balancing, in which case the circuit was at once resolved into simplex indicated by the appearance of their own signals—on the needle—which does not move when the circuit is balanced.

Further experiment has, however, demonstrated an unlooked for fact, viz., that there is no need to have specially wound coils to duplex a single needle. The ordinary coils can be operated by the simple act of connecting the wire from the key to the brass connection at the back, when if the coils are of equal resistance and differentiated, you have a ready-made duplex to your hand. We have no doubt that this latter fact will be largely taken advantage of by the railway companies of Great Britain, who have by this free communication the means of duplexing their busy circuits and enjoying the advantage of keeping intermediate stations upon their duplexed circuits as heretofore. When the resistances are known a large coil of iron wire will do for the known resistance, whilst a small rheostat of not more than 100 ohms in four or five sections will meet all requirements, and in that way railway superintendents can duplex their circuits at the minimum of cost.

HEDGES' PATENT SWITCHES.

THESE switches which were first brought out in 1881, and which since that date have commanded a large sale, have recently been re-designed and several important improvements have been introduced. The

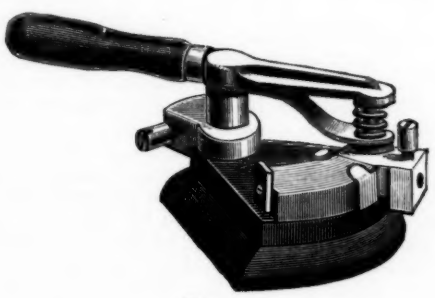


FIG. 1.

chief feature is the arrangement for ensuring good rubbing contact between the surfaces, which may be briefly explained as follows:—The horizontal

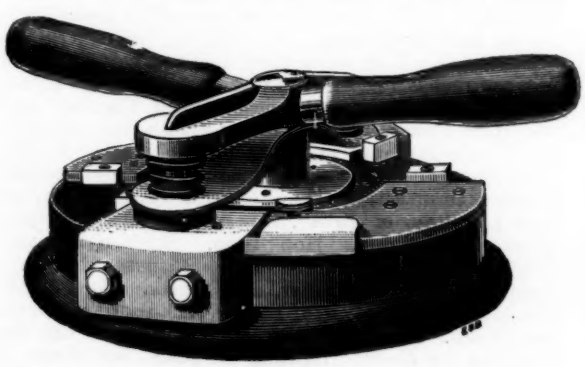


FIG. 2.

brass arm carries near its end a vertical pin which fits *loosely* into the circular copper contact piece below, and, the latter being pressed downwards by means of a strong spiral spring, it bears evenly on the brass segment. The current is conveyed from the lever bearing to the circular contact piece by means of a very flexible strip of laminated copper. Wiping springs are attached to the contact segments which take the spark and thus save the main contacts from being damaged.

Fig. 1 shows a switch of this type suitable for carrying 100 ampères at 50 volts. For larger currents where the contact area is larger and the springs stronger, they are made double-break as shown in fig. 2, the object being to balance the pressure of the springs.

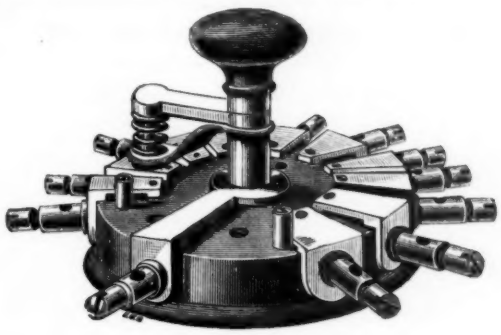


FIG. 3.

For high E.M.F. the double-break is also an advantage.

Fig. 3 shows this type of switch adapted to the purposes of a commutator, *e.g.*, in connection with variable resistances, inserting extra cells in battery circuits, &c.

The above switches (which are mounted on enamelled slate or wood bases) are manufactured by the Globe Electrical and Engineering Company.

PULL OF THE TONGUE OF TELEGRAPH RELAYS.

THE pull which the coils of telegraph relays exert upon their tongue is an important factor in determining their efficiency, since the efficiency of the relay, for slow working, varies directly as the pull; while for automatic working the efficiency varies as the square root of the pull. But in automatic working the efficiency also varies inversely as the square root of the inertia of the tongue and inversely as the square root of its play. And the magnetic inertia of the coils and the friction of the pivot plays an important part in impeding the speed.

The following measurements made with the large and small P.O. standard relays, the Siemens relay, and the large P.O. non-polarised relay, are, I trust, of some interest, inasmuch as they indicate the best position to place the inducing magnet, and show the effects of having a greater or less distance between the pole pieces. The instrument with which the measurements were made is described in the ELECTRICAL REVIEW, September 12th 1885:—

SMALL STANDARD RELAY.

Coils connected in Series. Resistance 400$^{\omega}$.

Distance of magnet from tongue.	Pull at contacts due to a bias at contacts of $\frac{1}{50}$ inch.	Pull at contacts due to one milliampere.
Inches.	Ounces.	Ounces.
$1\frac{1}{16}$	·065	·02
$\frac{1}{8}$	·05	·02
$\frac{2}{8}$	·045	·0184
$\frac{3}{8}$	·038	·017
$\frac{4}{8}$	·034	·0158
$\frac{5}{8}$	·031	·015
$\frac{6}{8}$	·027	·0144
$\frac{7}{8}$	·025	·0142
$\frac{8}{8}$	·023	·0138

PULL DUE TO BIAS.

Bias at contacts.	Pull at contacts.	Bias at contacts.	Pull at contacts.
Inches.	Ounces.	Inches.	Ounces.
$\frac{1}{200}$	·025	$\frac{3}{100}$	·156
$\frac{1}{100}$	·05	$\frac{7}{200}$	·2
$\frac{3}{200}$	·075	$\frac{1}{25}$	·25
$\frac{1}{50}$	·1	$\frac{9}{200}$	·33
$\frac{1}{40}$	·125	$\frac{1}{20}$	·45

LARGE STANDARD RELAY.

Coils connected in Series. Resistance 200$^{\omega}$.

Distance of inducing magnet from tongue.	Pull due to bias of $\frac{1}{50}$ at contacts.	Pull at contacts due to one milliampère.
Inches.	Ounces.	Ounces.
Close	·62	·068
$\frac{1}{150}$	·36	·056
$\frac{1}{93}$	·3	·052
$\frac{2}{93}$	·25	·050
$\frac{3}{93}$	·22	·046
$\frac{4}{93}$	·2	·042

It will be observed that as the distance between the inducing magnet and the tongue is increased the pull due to bias decreases more rapidly than the pull due to the current.

In polarised relays the pull is exactly proportional to the current's strength.

In the large standard relay the pull is proportional to the bias up to $\frac{1}{50}$ inch; it then increases more rapidly.

The large standard relay exerts a pull of $2\frac{1}{2}$ to $2\frac{3}{4}$ that of the small one with the same current. But the pull of the large relay is about six times as much as that of the small one with the same bias.

SIEMENS RELAY.

Tongue nearly $\frac{1}{8}$*th inch thick. Resistance* 540$^{\omega}$.

Distance apart of pole pieces.	Pull at contact, due to 10 milliampères.
Inches.	Ounces.
$\frac{5}{16}$	·1
$\frac{9}{16}$	·12
$\frac{1}{2}$	·14
$\frac{7}{16}$	·17
$\frac{5}{8}$	·23
$\frac{13}{16}$	·32
$\frac{1}{4}$	·45
$\frac{7}{32}$	·65
$\frac{3}{16}$	1·2
$\frac{5}{32}$	1·5

The distance between the pole pieces of the large standard relay is about $\frac{3}{16}$th inch. At this distance apart the Siemens relay exerts double the pull of the standard relay; but the magnetic inertia of the Siemens relay is possibly much the greater.

LARGE NON-POLARISED RELAY.

Coils connected in Series. Resistance 200$^{\omega}$.

TONGUE RESTING ON CORES.

Current.	Pull at contact.
Milliampères.	Ounces.
7·5	·31
10	·53
15	1·2
20	2·0
25	2·9
30	4·1
35	5·4
40	7·1

The pull increases in a slightly less proportion than the square of the current.

PULL WITH 20 MILLIAMPERES.

Coils in Series.

Revolutions, contact screw turned through	Pull at contacts.
	Ounces.
$\frac{1}{8}$	1·74
$\frac{1}{4}$	1·0
$\frac{3}{8}$	·74
$\frac{1}{2}$	·6
$\frac{5}{8}$	·52
$\frac{3}{4}$	·44
$\frac{7}{8}$	·38
1	·32
Tongue on core	2·0

With weaker currents the pull decreases more rapidly as the distance of the tongue from the core increases.

W. MOON.

ELECTRIC LIGHTING IN VIENNA.

ACCORDING to the report of the British Consul at Vienna, nothing is wanting but the necessary capital to bring about the adoption of electric lighting for public as well as private purposes in that city to a much greater extent than at present. "The electric companies now transacting business in Vienna," says the Consul, "have so little capital at their command that they are compelled to insist upon immediate payment for all investments made on behalf of and services rendered to their customers. I am assured by those familiar with the subject that any electric lighting company, irrespective of its system, could at once enter upon a most lucrative and thriving business in Vienna if its capital were sufficient to enable it to extend the necessary credit to its customers. The most important electric lighting company now transacting business in Vienna is that of Messrs. Siemens and Halske, a branch of the German firm at Berlin. It manufactures lamps and machines in Germany, imports them into Austria, paying a considerable duty, and thus increasing the price of what might be produced here on much lower terms. This firm has obtained a concession from the Government for the building of a central station, but it seems undecided whether it will avail itself of the privilege. A similar state of things exists with regard to the firm of B. Eggar & Co. From want of capital, the above and other firms have done but a very limited business in Vienna. In the provinces their business is more extensive, as large industrial establishments have made use of the light. In these establishments the price per hour for arc lights varies from 1·2d to 3·6d., and for incandescent lamps from ·12d to ·48d., according as gas, steam, or water is used as a motor. The Imperial Continental Gas Association, which has the contract for lighting the city, has organised itself as an electric lighting company, and has contracted for the lighting by electricity of the Burg Theatre, the two Imperial Royal Theatres, and the Opera House. It is brought against the company that it desires only to be in the field so as to take proper care of its extensive business interests against possible competition. The electric systems adopted here are those of Brush, Zipernowsky-Déri, Edison, Gramme, Gülcher, Hopkinson, Schmelsert, and Siemens. The arc lights used are those of Brush, Gramme, Gülcher, Hefner, and Krizik. The incandescent lamps are those of Lane-Fox, Edison, Siemens, and Swan. No reliable or sufficient water can be obtained for electric lighting purposes, but there is water enough for the use of steam engines easily obtainable anywhere in the city. The fuel most generally used in this city is coal, the best quality of which is sold at from 1s. 10d. to 2s. per cwt.

"The contract with the Imperial Continental Gas

Association ensures that body a monopoly until the expiration of the contract on October 31st, 1899, up to which time no other company can lay pipes in the street. The price of gas is:—For all-night public flame—sixteen candles—£3 16s. 5d. per annum; a half night's flame, £1 19s. per annum; for private use, the price is 5s. 5d. per 1,000 cubic feet; for public use, 4s. per 1,000 cubic feet. The total consumption of gas for private and public has been estimated at from 1,758,300,000 to 2,109,960,000 cubic feet. The usual prices paid for ordinary labour are from 2s. to 2s. 6d. a day, and for skilled labour of the highest order from 4s. to 8s. a day. I am informed that the firm of Kremenezky, Mayer & Co., of 59, Währingerstrasse, Vienna, and also Mr. F. R. Krizik, of Prague, a prominent electrician, surnamed the Czechian Edison, take great interest in the establishment of an electric lighting company in Vienna, and are ready to tender the use of their establishment as a basis for more extensive operations."

Under the heading of "English Enterprise in Vienna," the correspondent of the *Daily Chronicle* in that capital writes as follows:—"The Vienna public are much interested just now in a conflict which has arisen between the Municipality and the British Gas Company which has been lighting the Austrian capital for more than 40 years. The matter will also be of interest to the English public as showing what obstacles are placed in the way of English enterprise in Vienna, and also how necessary it is that the utmost caution should be exercised in dealing with the officials of this country. The company in question is the first that has attempted to introduce electric lighting on a large scale into Vienna, in spite of the opposition of the Town Council. Endless quarrels have been going on between the two parties relative to the gas lighting, and many law suits have been fought in which the company has been uniformly victorious.

"In February, 1885, the company obtained a contract for lighting the two Imperial theatres by electricity for the space of 20 years, and they were to have a preference if it should be decided to introduce the electric light into the Imperial Palace or any other public buidings. The contract was signed by the late Baron von Hoffman as Intendant of the Imperial theatres, and ratified by Prince Hohenlohe and Count Taaffe, representing the Emperor. The company had scarcely begun the necessary preparations for the execution of the works before the annoyances alluded to began. An application had to be made for the erection of a central station in the proximity of the theatres. All were against them—the Town Council, the Stadthalter, and private persons all opposed the erection of such a station. After going through all the courts, however, the matter was finally settled by the Minister of the Interior declaring in favour of the company. The latter then proceeded with the erection of their central station, involving an outlay of about two millions of florins, and then applied to the town for permission to lay their cables in the streets. This application was made in the early part of June, 1885.

"The Town Council pigeon-holed the application for a half-year, and then declared that they were unable to enter into any contract with the company. They contend that the streets are the property of the commune, and that the use of them for the purpose of laying an underground cable can only be arranged by means of a provisional decree which may be withdrawn at any time, the Commune having the right to make alterations when and where it pleases in the laying of the wires, and under certain conditions to take over the whole electric establishment. Besides all this, the Commune demands a rent of something like 40,000 florins per kilometre for the use of the streets during the time the cable is being laid, although the tramway company which has its rails upon the streets only pays 2,000 florins. In face of these monstrous demands, the company informed the Imperial Court that the fulfilment of its contract was impossible, but as the municipality still persists in its exorbitant claims the gas company has determined to fight the matter out. It has done all in its power to fulfil its contract; the central station stands ready for use, the preliminary work in the opera house and also in the new Burg Theatre is completed, only the cable in the streets is wanting, and that simply because the municipality has opposed the carrying out of the work. The new Burg Theatre has been so constructed that it can only be lighted by electricity, and it cannot therefore be opened so long as it pleases the municipality to maintain its present attitude. The public are indignant and the Press unanimously condemns the proceedings of the municipal council. These representatives of the loyal Vienna people push their rancour so far as even to disregard the wishes of their monarch."

REVIEW.

Electricity and Magnetism as Cosmotelluric Forces. (*Elektricitat und Magnetismus als kosmotellurische kraefte.*) By Dr. THEODOR FLOH. Vienna, Pest, and Leipzig: Hartleben.

This work, which forms the 37th volume of the "Electro-technical Library," now in course of appearance, can scarcely lay claim to a technical character. It views electricity and magnetism as energies affecting important terrestrial phenomena and extending their influence to cosmic, or, at least, to interplanetary relations.

The author sets out with an account of the magnetic needle and of terrestrial magnetism in general. An intimate connection between the movements of the needle and the position of the sun, and the condition of its surface, is recognised as appearing in the 26-days periodicity of the magnetic perturbations. No reference is made, however, to the alleged period of about eleven years traced in the sun-spots, and considered by some observers to influence electric and magnetic, as well as thermic and even vital phenomena.

The *aurora borealis* is considered at some length, and the interesting fact is mentioned that a phenomenon of this nature of striking beauty, witnessed by the author at Bamberg, in February, 1872, was not accompanied by any magnetic perturbation.

Passing over to telluric electricity, Dr. Floh treats in succession of electric earth currents, of atmospheric electricity, and the electricity of clouds. Ozone and antezone are discussed from an electrical, a chemical, and a sanitary point of view. Here we find that the recent researches of Emil Schœnc, of Moscow, have not been overlooked. This investigator, whilst admitting the possible presence of ozone in the air, considers that it has not been absolutely demonstrated, since the reaction usually depended upon may be likewise due to the peroxide of hydrogen. The records of its detection in the air, and of the accompanying meteorological circumstances are certainly remarkable, chiefly for their contradictory character. Zittel observed that the air of the Libyan desert, in its most sterile parts, which is not remarkably salubrious, was decidedly richer in ozone than that of the fruitful oases, or in the valley of the Nile.

The influence of ozone upon the sanitary condition of seasons and localities, is, to say the least, far from proven. Upon epidemics it exerts no appreciable influence, and inflammatory affections occur quite irrespective of its higher or lower proportion. Oxygen gas mixed with $\frac{1}{240}$th part of ozone proves fatal to all animals if inhaled. Of course, nothing at all approaching this proportion ever occurs in nature.

The luminous phenomenon known as Helen, Castor and Pollux, St. Elmo's fire, &c., is described as having become connected with a number of superstitions. Hence many, especially of the older accounts of its occurrence, are not trustworthy. This is to be regretted, since we have to distinguish between a purely

electric phenomenon and the imperfectly explained "Jack o' lantern," or "Will o' the wisp," and, perhaps, also the odic light of Von Reichenbach. Volta, indeed, referred the "Jack o' lantern" to electric action, supposing it to consist of phosphoretted hydrogen, ignited by an electric spark. This view must be entirely rejected, since the presence of phosphoretted hydrogen in the air, though often surmised, has never been demonstrated. Our author describes some thoroughly authenticated cases of the "Jack o' lantern," one observed and described by the eminent astronomer, Bessel.

The section on lightning and thunder treats, for the most part, of facts familiar to the public. A case is recorded of a Mr. Tipping, of Shrewsbury, who in August, 1885, saw distinctly two flashes striking upwards from the ground to the clouds. This phenomenon, very rare and perhaps not perfectly established, might have deserved a further investigation. If we remember aright, it was admitted as possible by the late Sir D. Brewster.

Some of the effects of lightning here described, though well authenticated, are hard to understand, and may engage (perhaps profitably) the attention of specialists. To the alleged connection of electric action with earthquakes we find no reference.

As regards the supposed influence of electric storms upon the vegetable world, no certainty has yet been reached. Some maintain that thundrous seasons and thundrous localities are especially fruitful. We have certainly noticed that when an electric storm has occurred in the night, an extraordinary number of roses are found open in the morning, though on the previous day the buds did not seem sufficiently advanced. On the other hand, the fall of temperature, which in Britain almost invariably follows within a few hours after a thunderstorm, has often a most disastrous influence upon all crops. On the Continent fearful damage is done by the accompanying hailstones.

In a hail-storm here recorded as having taken place in 1883 at Broby, in Sweden, the stones, which reached the size of ducks' eggs, contained milk-white fragments of quartz, the size of beans! This fact, it must be added, is authenticated by no less a scientific authority than Baron Nordenskiöld.

We can strongly recommend the present work to all students of physics and meteorology.

THE PROPOSED ELECTRIC RAILWAY AT LITTLEHAMPTON.

ON Thursday last week Major-General Hutchinson, R.E., Board of Trade Inspector, opened an inquiry at Littlehampton with reference to the scheme which has been proposed for the running of an electric tramway between the railway station and the pier. There was a large and influential attendance, including the steward to the Duke of Norfolk (owner of the greater part of Littlehampton), who stated that although his Grace was personally unfavourable to the proposal, he was quite ready to give it his assent if the electric tramway was desired by the majority of the inhabitants. It having been decided to hear objections first,

Mr. G. S. CONSTABLE handed in memorials from fifty owners and occupiers of property on the sea-front, and from 100 persons resident in other parts of the town against the scheme. He contended that the proposal was altogether unreasonable, as High Street was in some places only 15 feet wide, and traffic would necessarily be impeded, both there and in the main thoroughfare. The Inspector, on this point had remarked, at the outset, that the mode in which the tramway, if agreed to, would be laid was a purely technical question. He had recommended that in the narrow streets there should be a "double single line," so that there would always be room for traffic to pass.

Mr. LEAR opposed for the Ferry Trustees, who possess jurisdiction over the roads on which the tramway would be laid, and also "for other objectors." He contended that the junction of the Terminus Road with High Street was altogether too narrow to admit of a tramway being laid there. Had the Local Board really given its consent?

The INSPECTOR replied in the affirmative, and intimated that it had been laid before the Board of Trade.

Mr. LEAR then proceeded to contend that in various respects the tramway would be extremely dangerous. With few exceptions, all the owners of property on the proposed route objected to it. The speaker next dealt with the recent proceedings having reference to the Brighton Electric Railway, with the view of showing its danger, and contended that if such a mode of travelling were established at Littlehampton the town would no longer enjoy that immunity from accidents which had hitherto distinguished it.

The INSPECTOR observed that there was no doubt that electricity frightened horses quite as much as steam, for they were always startled by anything moving without any visible means. Until more was known of electricity as a means of motion, he could not recommend the Board of Trade to give their consent to the scheme. However, so that the promoters might not be thrown overboard, he had suggested that horse-power should be substituted for electricity, and that the latter should be prohibited until the consent of the Board of Trade had been obtained at some future time. At present they were very much in the dark, the only street electric tramway being at Blackpool, in a very wide road.

Mr. PORTER then opened the case on behalf of the proposal, severely criticising the assertion by Mr. Constable that the tramway would cause obstruction; Mr. Constable was a large brewer, and was the principal obstructor of the High Street with his vans and waggons. The electric railway would only take up three feet; Mr. Constable often took up the whole road. He handed in a memorial in support of the scheme signed by nearly all the residents of High Street and altogether by 215 persons, including five members of the Local Board out of eight (one having died) and 49 owners or occupiers on the line of route. The consent of the Local Board having been obtained, the promoters of the scheme felt that they were legally representing the town.

Mr. CHARLES JAMES DAINTREY, solicitor, said that he was the promoter of the scheme, which he considered was perfectly feasible and calculated to bring money into the town. The agitation against it had been organised during the past few days. Littlehampton was a favourite watering place, and during last year 175,000 persons went by rail to and from the town. The signatures on the memorial in favour of the scheme represented a rateable value of £5,000, while that of the whole town was only £20,000. Signatures from others than "frontagers" had only been solicited in a few instances.

Mr. CHARLES HENRY KNIGHT, auctioneer, expressed an opinion that the proposed tramway would be a great convenience, and would prove, if propelled by electricity, a great attraction to visitors. He could not so heartily approve of a horse-tram. In his opinion the decision of the Brighton Town Council with reference to Mr. Volk's electric railway would carry a good deal more weight than Judge Martineau's judgment.

Other evidence having been given in support of the scheme, the inquiry closed.

THE AURORA BOREALIS.

THE Finnish *savant*, Professor Selim Lemström, well-known for his researches and studies of the remarkable electrical phenomenon, the aurora borealis, has just issued in Swedish an important work containing the results of the same.

Having referred to the general forms assumed by the phenomenon in the Arctic regions, the *savant* describes the peculiar form observed by him in the North of Finland, viz., a coruscating luminosity around prominent objects, as, for instance, the tops of mountains, houses, &c. This phenomenon, it may be mentioned, Prof. Lemström maintains is a kind of aurora borealis, whereas another celebrated student of the same, Dr. Sophus Trowholt, pronounces it to be a kind of St. Elmo's fire. The professor then gives an account of the periodicity of the aurora borealis in its daily and yearly periods of maximum and minimum, and also of the relations between the phenomenon and the terrestrial magnetic storms and the sun spots. Other parts of the work deal with the geographical extension of the aurora borealis, its height above the earth's crust, the natures and the effects of the terrestrial magnetism and the aurora borealis, concluding with the author's scientific demonstration of the phenomenon being of an electrical nature. Finally, he describes the electrical currents at work in the air, and the experiments he effected in Lapland some few years ago when he succeeded, for the first time in the history of science, in producing an artificial aurora borealis on the top of a mountain by means of a specially constructed discharging apparatus, viz., a network of copper wires on which steel points were fixed at certain intervals. The author gives a very clear and vivid description of the electrical forces at work in the atmosphere or space at a height from the earth of from 40 to 70 kilometres. Thanks to scientific investigations of recent years we now know that these forces are subject to strict natural laws. The aurora borealis is, we learn, an *electrical* phenomenon in a form different to lightning, but still of an atmospheric nature. At a certain distance from each pole is a belt or zone whence a continuous but varying discharge of electricity into the atmosphere takes place. This is the aurora borealis and australis. This theory is now accepted by all leading *savants* as the only natural explanation of the phenomenon, and it has recently been greatly strengthened by the removal of one important point against it, viz., that electricity could not be transmitted through a vacuum or chamber of rarified air, an

assumption disapproved by Prof. Edlund, the celebrated Swedish physicist.

Prof. Lemström demonstrates that the aurora borealis has a double periodicity of about 11 and 56 years, and that the terrestrial magnetic storms follow the same laws, and that these, too, strange to say, coincide with those regulating the sun spots.

Prof. Lemström's work is a valuable contribution to electrical science, and unravels to a considerable extent the mysteries which have hitherto shrouded the nature and origin of the remarkable electrical phenomenon known as the aurora borealis or northern lights.

NATIONAL ELECTRIC LIGHT ASSOCIATION.*

HIGH INSULATION.

By C. C. HASKINS.

The electric lighting enterprise has shown to the civilised world that it has firmly planted roots, and has come to stay. It has passed the preliminary skirmishing incidental to the period of infancy; it has made for itself an honourable record as an earnest, brave combatant, and won its way through the lines of its original enemy—the illuminating gas phalanx—which now meekly holds out its hand to proffer the fraternal grip of partnership; and it numbers among its friends leaders in the army of underwriters—a force which, lacking knowledge on the subject, would accept no invitation to the christening of the new-born demon of light.

While commending and applauding the excellent results thus far attained, I trust I may be permitted to hint at a few possible opportunities which seem to me to point at substantial achievements in the future.

I would modestly, but very positively, suggest that a cheap installation, an installation which at the commencement called for a very modest amount of money; one in which drawer knobs usurped the place of the glass insulator, in which what Miller, of Cincinnati, calls undertaker's wire is strung on telephone knobs along the face of buildings; where, to reinforce the insulation through elevator shafts, under sidewalk crossings, through steam-damp rooms, &c., a wrapping of tape is rubbed down with a lick and a stick, like a postage stamp, to become, as soon as the organic oil has evaporated, of about as much value for the purposes of insulation as a molasses-covered rag; where a dozen similarly ineffectual subterfuges were used—that kind of cheap installations are in general the most expensive in the long run, if they manage to live at all. Better work in the outset is far more satisfactory to patience as well as to pocket, to dynamo man as well as to director. The use of the wire referred to for outside purposes is a loud-crying evil. In this particular direction but little progress has been made; this relic of the barbarous days of electric lighting still lives.

In a recent paper by Mr. I. N. Miller, this matter of using inside wire for outside purposes is quite thoroughly canvassed; and I wish to call particular attention to a few facts relative to the insulation of the underwriter wire when moistened. Mr. Miller says:—

"Careful experiments made by immersing 12 inches of this wire in a 6 × 8 jar filled with water, the ends extending above the jar, so that the water would come in contact with the covering only, shows the following insulating properties:—

	Ohms.
After 1 minute's time, resistance.....	115,000
" 3 " " "	4,170
" 5 " " "	1,770
" 1 hour's " "	280

"One hundred cells of battery were used in making the tests, one pole of the battery being connected with the water in the jar, the other pole with the copper conductor."

I do not believe there is any representative of a well-known electric light system present who considers an insulation of 280 ohms resistance sufficient to protect any unfortunate who grounds the line of a fair-sized arc light circuit through his body at any point in the line; or would like such a wire to rest upon his porch roof or be on terms of particular intimacy with his telephone apparatus. Yet there are hundreds of just such lines throughout this country, and they now and then get in their work; and there was a time when the makers professed to, and others did believe on account of its name principally—that underwriter's wire was perfectly and positively safe from every standpoint of person and property. It was cheap, too, but perhaps that had nothing to do with it. We all thoroughly understand that it is the second ground which does the mischief; but in a well-soaked line of underwriter's wire the second, if not the fortieth leak, is on, and I have seen a case, not in my own bailiwick, where the deductions from rental accounts because of this wet-rag insulation, in one month, would have put kerite wire at every exposed spot, and prevented shutting down for every heavy rain. The use of some good form of waterproof wire, when it is necessary to run a line along the front of a building to an outside lamp will add greatly to the general insulation of the line. It may be joined to the inferior wire—which is first-class, on porcelain knobs, for inside work—at a point inside the building where the storm cannot reach. It will cost a little more, but this expenditure will be amply repaid through the maintenance account, and assist in keeping the rental refunding account at a minimum.

Since the last meeting of this association I have had the pleasure of preparing and reading a paper before the Western Association of Underwriters, on the subject of electric lighting. While there was a remarkable lack of knowledge on the subject, I did not find the gentlemen unreasonable, but, on the contrary, earnest and curious, and anxious to know something of a force of which they had but the most vague ideas: and the thought then occurred to me, that if there were a fraternal exchange of opinion between the two interests, a good fellowship created between the insurance and the electric light people, much good would be the result of the alliance. The two parties are a couple of good fellows who should be well acquainted with each other.

If, as was suggested at the January meeting of the Electric Club in New York, each of us could capture an insurance man and bring him in to discuss this matter with us—if we could educate them in this matter—I feel certain a strong point would be gained. A timid child will enter and go peacefully to sleep, in a lonely room, if a light is burning, where no persuasion would induce it to venture in the dark; and the insurance agent, no less than the general public, is nervously groping in the dark whenever he discusses the subject of electric illumination. There is still another incentive, which appeals to the sensitive electric light man's feelings, and argues potently in favour of better average insulation.

You have probably all noticed the different action of the lamps on a central plant circuit, when in the one instance the rag-wrapped wire was well soaked by summer rains, and in another instance the air was crisp and dry in the hard frozen season. The coal-pile, too, feels the effect, and so does the patron. With the mercury for a few hours in the neighbourhood of zero, what was nearly no insulation becomes a matter of megohms. All electric wires show this result, from the pigmy telephone and short distance lines up to the fire alarm and long telegraph systems. In such weather, during the cold snap in January, direct telegraphing was done, not as an experiment, but as business, between Toronto and Victoria, British Columbia. This frozen condition of affairs generally along the line conserves to the wire itself all, or nearly all, the electrical energy which the generator furnishes for the use of the electro-magnets or the chemical solution of the receiving apparatus. Now, if the tension of the electrical pressure of a telegraph battery is capable of forcing itself away from a conductor of far more than ample capacity, to escape down a pole to ground during a rain, what are the possibilities to a dynamo current so many times more energetic both as to pressure and quantity, when its route to earth is across half an inch or so of the knob, through a soaked thread wrapping to the wet wood, iron, brick, or stone, to which it is made fast at intervals of only a few feet?

I have endeavoured to show from several standpoints the necessity, as I contend, for high insulation, and I shall bring this paper to a close by offering for your consideration a suggestion which, while I am aware it is not entirely new, has one feature which I have not met with elsewhere. It is simply this: Provide your superintendent, engineer, inspector or the proper employé, by whatever name you may call him, with proper, reliable instruments for measuring the insulation resistance of your lines. In saying proper instruments, I trust no one will for a moment believe that I mean a magneto. A combination of galvanometer with 20 cells of silver chloride battery in one box and a Wheatstone bridge in another will give you an outfit with which any measuring can be done, from small fractions of an ohm up to over a megohm. Provide with the apparatus a record book, ruled for date, number of circuit, number of ohms and a large space for remarks. Let the measurements be made at least twice a week, or, still better, oftener, and the record made whether up to, or below, the standard. In the latter case, when the trouble is found, full particulars should be entered in the remarks column.

Now, if a fire occurs where there is any possibility of an electric wire having contributed to the trouble, that dumb witness, if it has been properly kept, will contribute more hard facts to ward off an unjust accusation than could be shown by your president and the entire board of directors in one long, weary day.

DISCUSSION.

Mr. F. A. MASON: In conversation with insurance inspectors I am continually met by questions of this sort: "We do not know much about wires or about insulation, and we want to know something, and we wish that there were something authoritative we could lean on. We cannot examine different insulations, we only guess at what is the proper insulation for us to pass." It would seem to me that this is the place and that this is the time for some authoritative statement to be made, and without following with any remarks of my own I wish to offer the following resolution:—

Resolved—That a commission of five members of the National Electric Light Association be appointed whose duty shall be:

First.—To determine what qualities are essential to good insulation for electric light wires.

Second.—To examine such insulation as may be submitted to it and to determine in what degrees the different insulations submitted possess the virtues required.

Third.—To report at the next meeting of the Association the results of their investigation.

Mr. STEUART: I hope that these resolutions will be adopted

* Meetings held at Philadelphia, from February 15th, 1887.

and a committee will be appointed to consider this question. Give the insurance companies and give the public to understand that this Association has taken a stand before them in which they pretend to say, and propose to say, that they are giving to it the right thing and that they are going to give the members the opportunity of having a committee to determine whether they are doing the right thing. Then it will stand in a proper position before the public, and they will gain the confidence of the public. For that reason I think this committee should be appointed and I think it will be.

Prof. HOUSTON: I was not present at the meeting this morning when the paper under discussion was read. I simply rise to ask whether the discussion related entirely to the subject of insulation and insulating power? It seems to me that an electric light wire to be safe should possess three properties. Unfortunately, the three properties would be very difficult to be found associated together in the same wire. It should not only possess high insulation, but it should be impervious to water or moisture, and should be incombustible. Whether or not these properties can all be found in one and the same conductor I am unable to say, but when that conductor is found that possesses this threefold group of properties I am sure the best conductor will be found for economy and safety in working. I simply rose to ask the question whether under the head of insulating power the other two equally important requisites, impermeability to water and incombustibility have been considered?

Mr. L. H. WEISSLEDER: Before this subject shall receive the sanction of this Association there should be an amendment. I think it would be a good thing to have it qualified, as under some circumstances there would be a great loss entailed in the rearrangement of wires and great loss to property, amounting to the confiscation of some plants running on a very small margin. And another thing; the gentleman who has just preceded me was speaking about insulators and a fire-proof covering at the same time. I might say that a wire thoroughly insulated does not affect the ground line or produce fire, because the fires produced have generally been in wet weather, and we have found in our own business in running into buildings, that sometimes the current would escape from the wet wood and produce a little conflagration and some damage. A great many complaints have arisen from this. A good many companies are equipped with good wires for ordinary weather, but if the wire were run against the iron cornice or a roof it might produce an escape and be unsafe to property, and, manifestly, a fire might occur.

Prof. HOUSTON: It is true that a wire well insulated originally may from moisture become a source of danger from fire, and might not be the cause of fire itself. But it is not true that the wire is free from danger as an incendiary; that is, the covering acting as an incendiary. A very serious fire is likely to occur on the outside of the wire itself. Surely, in a practical meeting like this, it must be well known to members that there are wires which, if inclined upward a little and touched at one end by a match, will shoot forth a column of flame almost as rapidly as a man can walk; there comes the danger. When my duties led me to inspect the circuits at the International Electrical Exhibition, of which I was the electrician, I remember very distinctly that we had to guard very carefully against wires of a readily ignitable type, and many a time have I tested wires from which the flame would run from one end to the other almost as rapidly as a man would walk. The trouble with such wires would be in danger from the current which traverses it carrying fire from one part of the building to another.

Mr. CALLENDER: I move as an amendment to the resolution that the first and second objects be kept in view, and that the third be left out. It seems to me that the object of the committee should be to investigate the question of what insulation is necessary, and that it should not be to determine what kind of insulator should be used, any more than a committee should be appointed to examine into which kind of dynamo is best, or which kind of lamp should be used. The object of the inquiry is one of very great importance, and its importance is growing day by day and being recognised by electric light companies; if the second and third part be left out, it seems to me the resolution would then cover all the points that should be investigated by this association.

Mr. MASON: I introduced these resolutions at the suggestion of a number of insurance inspectors, who said that they were not able to determine these questions; they had not time to investigate; they were obliged to pass upon installations; they were obliged to say whether they would or would not pass and use certain wires, and it seems to me that it does lie in the purview of this association to determine what are the needed qualities in the first place. I do not need to go on and mention that there are other qualities not in the way in a good insulation, but the gentleman who spoke a few moments ago on the legal aspects of the question made a very comprehensive point. Those of us who own installations and who are connected with electric light companies wish to be protected, and we are not protected to-day. I have the misfortune to be connected not alone with an electric lighting company, but also with a wire interest; but I speak now in connection with the first interest. We want to know whether we are protected against suits from telephone and telegraph companies, and from private individuals, if we have taken all due pains and precautions.

On being put to a vote Mr. Callender's amendment was lost and the original resolution carried.

The committee of five provided for in the resolution was then appointed by the chair, as follows: Prof. E. J. Houston, MM. Garver, R. T. Robinson, Carl Hering and Prof. W. D. Marks.

ELECTRIC LIGHTING ACT (1882) AMENDMENT BILL.

HOUSE OF LORDS, MONDAY, MARCH 21ST.

THE House having gone into Committee,

The Earl of CAMPERDOWN (in the absence of Lord Houghton, who had given notice of several amendments) moved that the following clause should be inserted before clause 1:—

"Notwithstanding anything in the Electric Lighting Act, 1882, no provisional order authorising the supply of electricity by any undertakers within the district of any local authority should be granted by the Board of Trade, except with the consent of such local authority, unless the Board of Trade, in any case in which the consent of such local authority is refused, are of opinion that, having regard to all the circumstances of the case, such consent ought to be dispensed with, and in such case they should make a special report stating the grounds on which they have dispensed with such consent."

He said that the object of that clause was to recognise the interests which local authorities had in such matters. As the law now stood, when a provisional order was sought by a company they did not necessarily apply for the consent of the local authority, but went direct to the Board of Trade. It was true the Board of Trade took the opinion of the local authority, and there were then ample means of stating objections. The change which was proposed was that in the first instance the company should go to the local authority and ask for their consent, and if that consent was refused the company had power to appeal to the Board of Trade against the decision of the local authority. The local authority would thus have a veto, which, however, the Board of Trade might override.

Lord THURLOW said he had no objection whatever to the new clause which had been proposed by the noble earl, as it was an accidental omission in the Bill.

Lord STANLEY of PRESTON said the Bill was similar to that of last year, and the Government were prepared to support it, provided this and similar amendments were accepted.

The insertion of the clause was then agreed to.

The Earl of CAMPERDOWN said he had an amendment on line 22 which raised a question of principle. The Bill proposed to give electric lighting companies a period of 42 years to enjoy the fruits of their enterprise, and at the expiration of that period any local authority was to be at liberty to purchase the undertaking upon the terms of paying the then market value of the goodwill of the undertaking. It appeared to him that this offered electric lighting companies a greater privilege than was necessary or desirable in the interests of the public. If, after the period of 42 years, local authorities had to pay for the goodwill of these undertakings, their purchase would become impossible. Not only would a monopoly be created, but it would be a perpetual monopoly, just as the terms on which gas and water undertakings could now be acquired were so exorbitant that their purchase was impossible. It would be quite sufficient to allow the company a monopoly of 42 years and then to pay for their plant, but not their goodwill.

Lord THURLOW regretted that he could not accept the amendment. The provision in the Bill was necessary for the encouragement of a new industry, and he believed there were no other alternatives to it but either to allow companies privileges for a greater length of time or to charge higher rates in order to recoup themselves for their outlay. He felt bound to take the sense of the House on this amendment.

Viscount BURY wished to endorse what had fallen from the noble lord who had last spoken. The Act of 1882 had failed because the terms offered to the companies had not been sufficient to induce them to invest their capital. He was glad that a revulsion of public feeling had taken place on this matter, and that a longer term of years was now to be accorded to undertakers of electric lighting. He did not think it unjust that the companies should be paid for the value of their goodwill, and should therefore oppose the amendment. He hoped that the words proposed to be inserted by the noble lord opposite would not be agreed to. If the Government would undertake to introduce at some future time a satisfactory measure dealing with this subject he thought that the noble lord would do well to be content with such an assurance instead of pressing forward a Bill which could not get beyond that House during the present Session.

Lord BALFOUR did not think that the electric lighting companies could demand to be placed upon the same footing as the existing gas and water companies. In his opinion the electric lighting companies ought to be glad to get such a Bill as this without waiting for what they might deem to be a more perfect measure.

Lord BRAMWELL trusted that their lordships would not agree to the amendment. What was the substance of this controversy? It was this—capitalists said that they would provide the necessary capital for carrying out electric schemes if the Legislature would give them time to obtain a reasonable amount of profit upon their undertaking, and that if such undertaking resulted in a profit instead of in a loss they were to receive compensation for the risk of loss they had run by being allowed to receive something like the reasonable value of their undertaking. The suggestion of the other side was that the capitalists were to run all the risk of loss and that when their undertaking had become a success they were to receive, not its full market value but merely—he would not say the old iron value—but the value of the plant less the amount of its depreciation. The result would be that,

assuming the plant had to be renewed every ten years, when the 40th year arrived the renewal of the plant would be scamped and every effort would be made by the undertakers to lessen the value of that which was about to be taken from them by the local authorities. This policy of the local authorities was a dog-in-the-manger policy. They said:—"We shall not do it ourselves; and you shall do it only on the terms we are willing to grant." Their lordships should remember that those unreasonable capitalists who desired to make such a profit were bound down in such a way that the dividends were limited to 10 per cent., and that when new capital was required it could be raised only on certain stringent conditions. He asked their lordships to bear in mind that not one of the witnesses called before the committee said that 42 years would give time enough, and if it did it was open to the objection that it would prevent electric undertakers from doing their best towards the end of the term. He therefore asked their lordships to reject one of the most unreasonable provisions ever proposed. As to the argument "Beware of another place," what did that mean? It meant that if their lordships did right here, others would do wrong elsewhere.

Lord LINGEN said that he agreed with the noble lord who spoke last but one that they were now dealing, not with a case of vested interests already created, but with one in which a new bargain was to be made in which the interests of all parties could be fairly and judicially considered without reference to the past. The figures brought before the committee impressed him with the magnitude of the question. The Birmingham Town Council in 1875 acquired the gas and waterworks of that town, for which they paid £3,500,000. In that payment £1,500,000 was for goodwill and was not represented by any works which they acquired. It represented the interest of the shareholders, and what was understood by "a going concern." The decision, therefore, to which their lordships might come was of very great importance to municipalities. As to municipalities coming forward as trading companies, it was to be observed that when those monopolies were created by consent, there was very little difficulty in the matter; but it complicated the case when the monopoly might be introduced without the consent of the local authority. That made the great difference between the case of towns and that of private persons who wished to have electric lighting introduced into their houses. It should be remembered that the local authorities had the interests of the community to consider. When these powers were given it was not only for the lighting of the streets, but of private houses. If very hard bargains were driven with the public on the introduction of those practical monopolies, it was almost certain that at some time or other the feeling would be to break through them, and probably on much less favourable terms to the companies than if, on the introduction of the enterprise, the promoters accepted reasonable and proper limitations.

Lord HERSCHELL said he was not able to follow his noble and learned friend in the view that municipalities, which represented the public, had not a right to make the best terms they could in the public interest when persons had to come to Parliament to get a monopoly.

Lord BRAMWELL: They have a perfect right to get the best possible bargain for the public.

Lord HERSCHELL observed that the public authorities were bound to take care that rights were not acquired by companies which would be injurious to the public. He agreed with the noble and learned lord that it would be mischievous to pass a measure in such terms as to prohibit the introduction of a system of lighting or of anything else which would be advantageous to the public. Hence they had to consider those two points—that on the one hand the municipalities should be able to make the best terms they could, and on the other that Parliament ought not to impose restrictions which would prevent the public from getting an advantage that large numbers of people desired. For his own part he should much regret any legislation which might have the effect of interfering with the introduction of electric lighting in private houses by those who desired it. As to the question whether the terms of the Bill were sufficient or not to promote the object in view, he thought one circumstance had been somewhat left out of sight. There could be no doubt that a monopoly was practically given to gas and water companies which were first in the field, and simply because there was not room for more than a limited number of gas and water pipes under the public streets; but with electric lighting that would not be the case because the space that would be occupied by such a system would be so comparatively small as to obviate all difficulties in this respect. He did not know whether under the Bill a municipality would be precluded from entering into competition with an electric lighting company for the term of 42 years.

Lord THURLOW: Not so.

Lord HERSCHELL said that in that case if the system of electric lighting turned out a success there would be no difficulty in giving the public a competing scheme if unreasonable terms were exacted by the company in existence. This might materially affect the view as to the terms which the promoters of a company would have a right to ask; it would strengthen their right to ask that the undertaking, when it was acquired, should be taken upon terms which would fairly recoup them for the risks they had incurred. His noble friend behind him had suggested a course which had been often taken in similar cases, and that was not merely to pay for the plant, machinery, and so on, but to take the average price of the shares for a number of years and the earnings for a number of years. That would seem to him to be a reasonable course. He believed that municipalities would be conciliated by some such proposal, much more than if the Bill was passed in its present form.

Lord RAYLEIGH said he objected to the omission of the words in question, and he did so not in the interests of capitalists, but in those of the public. If the words were omitted it was clear that the terms then offered under the Bill would be insufficient to attract capital. There was a general desire to encourage and develop this movement, and it would be a mistake to impose too severe terms at the outset.

Lord GRIMTHORPE said the House of Commons disregarded the evidence of competent authorities which was brought forward on this subject, and they all knew that the result was that the Act of 1882 had proved to be a great failure. The Select Committee of last year did the same thing, and he found on looking over the evidence that every single engineer and financier of experience who was examined was distinctly of opinion that the Bill in the form in which the noble lord opposite had put it would be again a failure. As the matter stood they had to choose between the opinions and evidence of the most competent electric engineers and scientific men, and that of a number of town clerks and aldermen, who, in 1882, practically deprived the kingdom of the advantages of the electric light by the terms for which they stipulated. A great deal had been said about monopoly; but the word was altogether inappropriate to the matter in hand, and the arguments founded upon it were incorrect. The point at issue simply was practically whether the property was to be sold for what it was worth, or the owners were to be obliged to sell it at a loss. As to gas and water companies, such an obligation as it was sought to impose in this case was never placed upon them, unless the practice had been very recently altered, and he saw no reason for imposing it on electric lighting companies. It seemed to him that if this important industry was not to be treated unfairly the amendment should be rejected.

Lord STANLEY of PRESTON was bound to say personally that he supported the amendment moved by his noble friend opposite, but there was a wide and an honest difference of opinion in many quarters with regard to it, and he should be sorry to prejudice in any way the action which any noble lord might wish to take in this matter. His noble friend behind him made a kind of appeal to him to say that the Government would bring in a Bill dealing with this subject. He did not think it would be honest on his part to give his noble friend such a pledge. He had already explained that it was owing to his having been prevented by circumstances from introducing any measure dealing with this question that he told the noble lord opposite that he thought it was advisable that he should proceed with this Bill, and that they should endeavour as far as they could to assist in passing it through the House. Therefore, he thought the matter ought not to be postponed, but dealt with at the present time. The question, then, was whether the Bill would be of the use it was intended to be if this amendment were added to it. He could not help thinking that in this matter they ought to go step by step. He was bound to a certain extent by negotiations and arrangements which took place consequent upon the committee of last year, and standing as he did, therefore, in the position of having to deal with this matter, he was bound to say that he preferred the lesser amendment instead of taking the larger step. In some way or other the question of the goodwill might hereafter have to be considered, but he did not feel himself able to accept that at the present time, and consequently he must vote against the amendment of the noble lord.

Viscount CRANBROOK said his noble friend who had just addressed the House spoke for himself alone, and not on behalf of the Government. For his own part he saw no reason whatever why a public body should get for less money that for which any private person would have to pay a larger sum. Therefore he should oppose the amendment.

The Earl of CRAWFORD and BALCARRES was confident that no local authority would have done what had been done by the personal care and attention given to the extension of electric lighting by members of the companies. In regard to the alleged creation of a new monopoly, he held that there was no monopoly in gas, which had to compete against oil and candles, and electric lighting ought not to be put upon any other footing than gas, because it would have to compete with gas, oil, and candles. No monopoly was asked for excepting that which the companies could create for themselves by the excellent quality of that which they supplied, and the moderate price they charged for it. As to what had been said about paying for old iron, he acknowledged that there was a difference between buying new machinery and buying the same machinery which had been laid down in the ground for a definite purpose. At the same time the proper price to be paid by the purchaser would be the value at the moment, and that would involve a reduction for depreciation from the original cost.

The Earl of GALLOWAY suggested the withdrawal of the amendment to the noble lord opposite, who must see that the feeling of the House was against him. Their lordships had to answer two questions. The first was, whether they were to deal out to electric lighting companies the same measure of justice they had dealt out to other companies; and the second was, whether they desired to incite the men of science to drive away from this country the best light in the world.

The Earl of CAMPERDOWN, in reply to questions which had been asked, said that he held that it would be most unfair that a local authority should have the power to compete with an electric lighting company during the 42 years for which a concession had been granted, and he did not believe that a local authority would

have such a power under the Bill. If the Board of Trade granted a concession to the private company for 42 years, he apprehended it would refuse a similar concession to any other company or to a local authority for the same district. How could we know without trial that the provisions of the Bill would be prohibitory of electric lighting experiments under the new term of 42 years? On the question of goodwill he would assent to a compromise, if one could be arranged. He was prepared to pay the value of plant and other things mentioned in the Bill, with a percentage added on account of compulsory purchase. But he was anxious to exclude uncertain calculations and valuations of prospective profits, which would be due to the expansion of a town and not to the outlay of an electric lighting company.

Their lordships divided on the question that the words stand part of the clause, when the numbers were—

Contents	45
Non-Contents...	10
Majority	—35.

The Earl of CAMPERDOWN said that, after their lordships' decision, he did not think it necessary to proceed with the remaining amendments on the paper.

Lord HERSCHELL said he did not quite understand why the words about goodwill had been introduced. He should have thought that if the undertaking were purchased on the terms of paying the value of the undertaking, that would have covered the whole thing.

Lord Grimthorpe and Lord Bramwell agreed with the words of the Bill.

The Lord CHANCELLOR said he thought the words were necessary.

The clause as amended was then agreed to.

The remaining clauses were then agreed to.

The Bill passed through Committee, and the House resumed.

A THIEF AND FIRE DETECTOR TELEGRAPH.

UNDER this heading in the REVIEW of December 24th last an illustrated description was given of the arrangement patented by Dr. Taussig for the sending of signals from private houses or other points on a circuit to a central station. On Tuesday the apparatus was installed at the Bow Street Police Station, where it is being put to the test by those concerned with a view to extended trials in connection with the police and the Fire Brigade. The various ways in which such a means of communication would be useful were fully pointed out, and may be summarised as follows:—(1.) Automatic Burglar Call.—Any door, window, desk, &c., is connected with the apparatus, and on this connection being broken by the opening of a door, &c., a message is sent automatically to the central station, giving the address of subscriber. (2.) Automatic Fire Alarm.—The apparatus is connected with a thermoscope, and when the temperature of the locality where the apparatus is placed, rises to a dangerous point, a message is sent automatically to the central station, giving address of subscriber. (3.) Calls by means of Morse Key.—By pressing a Morse key any message can be sent to the central station. (4.) Telephonic Communication.—After calling central station by means of the Morse key, telephonic communication can be carried on on the subscriber's line. (5.) Cutting Wires.—If any subscriber's wire should be cut, for instance by a burglar, a message is sent automatically to the central station.

Considering the simplicity of the wire connection and the small cost of the apparatus it is evident that it would at a relatively small expense, furnish a reliable protection to a large number of people, and that its merits commend it to the attention of the police, the Fire Brigade, insurance offices, and all who have property to protect.

ELECTRICAL DISTRIBUTION BY ALTERNATING CURRENTS AND TRANSFORMERS.

By RANKIN KENNEDY.

SYSTEMS—*Continued.*

(*Continued from page* 248.)

THE distribution of power by continuous currents of electric energy and electric motors requires motors which conform to exactly the same laws of action as far as their counter E.M.F. is concerned as alternating current transformers, in fact, an electric motor is simply a transformer, and its actions, government and regulation, are similar in every respect to those of a well designed induction coil transformer.

A system of distribution in parallel connection with constant E.M.F. supply demands a motor which shall have a counter E.M.F. very nearly equal to the E.M.F. in the supply conductors when no load is on the motor, and this counter E.M.F. should fall directly as the load is thrown on, and if this fall of counter E.M.F. is proportional to the load thrown on and sufficiently great, then the motor becomes self-regulating, always supposing this action to take place at a constant speed of rotation of the armature.

It is easy to calculate the required fall in counter E.M.F. to meet any given load thrown on to the motor with any given E.M.F. of supply. On the other hand, motors to be run in series order in the circuit of a constant current supply should be so constructed, that when no load is on the motor there should then be no counter E.M.F., or at least an amount of counter E.M.F. too small to be taken into account in the motor, and this counter E.M.F. should increase directly and proportionally as the load is thrown on the motor.

Motors constructed to satisfy these conditions even approximately would solve the problem of the distribution of small powers by electricity. I know not whether the method of winding motors with demagnetising regulating coils brings about this rise and fall of counter E.M.F. in motors, but I think that is the intention of winding them in such a manner.

I make these remarks here on the transformation of electric energy into power, or work, for the purpose of drawing attention to the similarity existing in the problems of transforming electric energy. The control of the counter forces is the only important point to attend to in constructing electric motors for transforming and distributing electric energy for motive power purposes; and this very point having been neglected may explain why not a single installation of electric motors driven from a common supply yet exists anywhere in this country.

To return to our subject, I may point out an error which some writers have fallen into when speaking of working alternating current transformers in series order. They say "a high tension current of small quantity passes through the whole system and this high tension current is transformed at the points requiring the lights into a current of low tension and larger volume;" now such language cannot be used in relation to a series system of distribution. In a series system the high tension exists only at the generator; at the terminals of the transformers the potential may be anything less than the potential at the generators; that depends entirely on the work being done in the secondary circuit.

In speaking of the series system we should remember that transformers working at constant current supply are designed, or rather ought to be designed to transform a constant current into a current which may be less in volume or greater in volume than the original current; they are then current transformers.

In speaking of the parallel system we should remember that in this system the potential at the terminals of the transformers is constant and high, and this constant high potential is transformed into a constant low potential in the secondary circuit; transformers in this system should be called electromotive force or potential transformers.

We want a current transformer for the series system. and a potential transformer for the parallel system.

As an illustration of this error in speaking of these systems of distribution, I may refer to page 185 of Gordon's work on electric lighting, where it is stated in connection with a series system of distribution, that the current is conveyed as a small current at high pressure, and an induction coil is placed in each house to transform this high pressure current into a current of more quantity and less pressure. Now, any system of distribution is not worth considering unless a large number of consumers can be supplied from one circuit, and supposing a pressure of 2,500 volts to be maintained at the generator as a maximum pressure, we should require about 40 ampères of a constant current in the mains *and also in the primary circuits of all the transformers* to distribute a little over 12,000 incandescent lamps.

Would 40 ampères be a small current capable of

being carried without loss through a long thin wire? No. Again, it is obvious that a good many houses would do with less than 40 ampères, and in these cases a transformer there would have to generate a secondary current of *greater pressure and less quantity* than that in the primary circuit of the transformers; the word *pressure* should not appear at all in connection with transformers in series. The sentence in this book describing the system should read, "An alternating current of *constant* quantity is sent into the primary and induces in the secondary a current of more or less quantity to meet the demand according to number of lamps in use." Even the pressure at the generator would not be always *high;* the pressure there would be extremely low sometimes, say during the day when only about 50 lamps might be in use in the system.

Then, again, it is stated that the primary wire is a thin wire and the secondary a thick wire; in transformers in such a system that is also a mistake. Whether you use the thick wire for the secondary and the thin for the primary or *vice versa*, depends altogether on whether you want a greater or a less current in the secondary than the fixed constant current in the primary. If the fixed constant current was 40 ampères and only 10 ampères wanted for use, it would be absurd to make the secondary wire carrying the 10 ampères thicker than the primary wire carrying 40 ampères; and further, given a good constant current transformer, it would be quite possible to light a large area with transformers in series, every one of which would have a thicker wire and a greater current in the primary circuit than in the secondary circuit.

A current transformer has yet to be invented, but fortunately for electrical distribution, all induction coils, converters, secondary generators, transformers or transformators, by whatever name they may be called, are potential transformers from the first one made by Faraday, 50 years ago, down to the latest development; they are all naturally applicable for working in parallel connection and for transforming high potentials or low potentials, but this fact lay ignored or unknown until 1883, when I published my discovery of it in these columns.

Since then even the most enthusiastic of the promotors of the so-called series systems have quietly adopted the parallel system after meeting with the inevitable failure which awaits every attempt to apply the induction coil as a current transformer.

The series system is now abandoned, and we find Gaulard and Gibbs working the parallel system in the United States and in France, Zipernowski and Deri working the same system in Milan and Rome, and Ferranti working the same system in London.

Zipernowski and Deri's patent comes first after 1883, and is dated 16th March, 1885, No. 3,379. Fig. 1 is taken from this, and illustrates the parallel system; here we have a system of mains at high potential, M, N, and at I., II., III., we have systems of low tension mains supplied through transformers; at C, in plan III., we have a regulating transformer in series with the low potential circuit.

In this specification is described a very effective and ingenious method of regulation, whereby the electromotive force at the terminals of the dynamo-electric generators is maintained constant; this is done by using a transformer with its fine wire circuit in series connection with the main wires, M, N.

The current in the secondary circuit of this transformer is of low tension and large volume, and it varies in volume directly in proportion as the high tension current in the mains varies; this low tension current is made to flow round the field magnets of the generator in one direction by means of a commutator, and hence an increase of current in the main conductors is accompanied by an increase of strength in the magnetic field of the generator

The next patent is Ferranti's, dated 11th December, 1885, No. 15,251, and to show what can be put into a British patent and give an idea of the contents of the specification, I give the whole claims here complete.

1.—The improved means for distributing electric energy consisting in providing high tension mains and low tension mains, and causing each low tension main to be fed from the high tension main through two or more convertors which are connected and disconnected as required.

2.—The combination of electric circuits and apparatus substantially as described in respect to figure 1 of the annexed drawings.

3.—An electric main consisting of two metallic tubes drawn one over the other with insulating material between forming part of the same circuit and maintained at a suitable difference of electric potential.

4.—The method substantially as described for forming joints in electric mains.

5.—The combination with a system consisting of a high pressure circuit, feeding low pressure circuits by the aid of electric convertors connected by branches with the high pressure circuit; of fuses or automatic cut out apparatus in the said branches operating to open the branch circuit when short circuiting occurs.

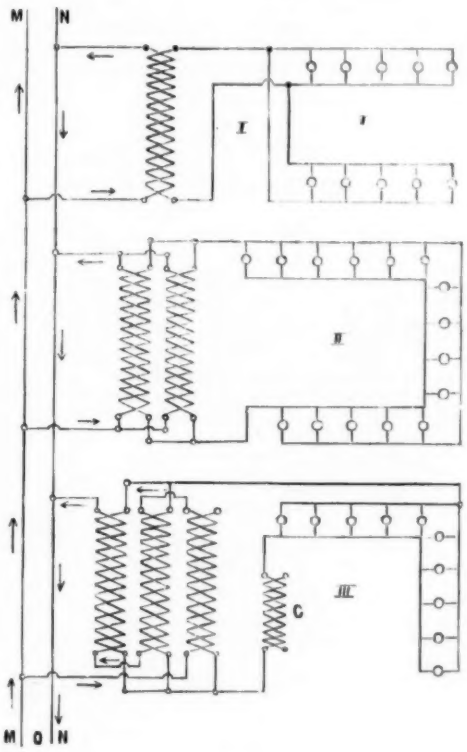


FIG. 1.

6.—The combination of a high tension circuit, convertor, low pressure circuit and fuse in the high tension circuit, substantially as described.

7.—The application of fuses in combination with high and low tension circuits and convertors substantially as described in respect to figures 6, 7, 8 and 9.

8.—The combination of the dynamo a producing alternating currents, the electric mains a^1 a^2; the two electrometers u u and the earth connection v; the whole forming an arrangement in which an accurate indication of any leakage in the mains is obtained.

9.—The combination of a dynamo producing alternating currents, a convertor connected with the primary of the dynamo, a wire in the secondary circuit of the convertor expanding and contracting with the variations of the current therein and operating to correct any variation from the normal condition substantially as described.

10.—My improvements substantially as described in the means for distributing electric energy.

The eighth claim is for a useful application of two electrometers to detect leakage in the mains.

The ninth claim is for a system of regulation by

means of a converter placed in series order in the main wires as is done by Zipernowski and Deri, with this difference, that the low tension current is passed through a Sir William Thomson's regulator, a wire which expands or contracts as the current varies, and this expansion or contraction operates regulating apparatus—may for instance govern the engine which drives the dynamos.

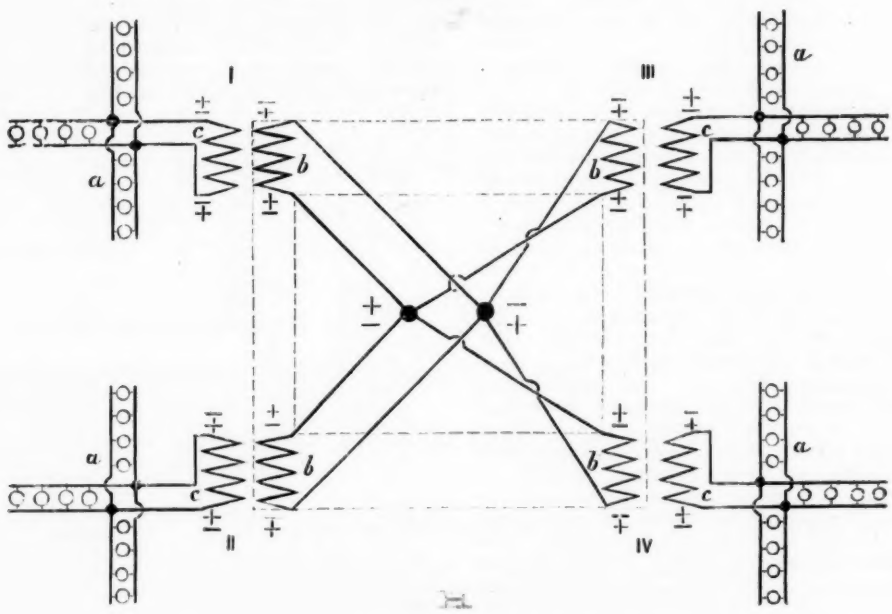
Claims 1 and 2 may be compared with Zipernowski's prior specification; claims 3, 4, 5, 6 and 7 are interesting, as appearing in a patent for the distribution of electric energy.

The next patent follows Ferranti's 19 days later, and is by Messrs. Siemens & Halske, dated December 30th, 1885, No. 16,038. This specification shows no knowledge of the self-regulating effects of the counter electromotive forces in the generators themselves. The patent is purely for a system of laying mains and feeders from a central supply station and has some value as such, although for wide distribution it is hard to see how to apply this system. Fig. 2 shows the system.

In the specification of Edwards and Normandy, 1878, a proposal is made to employ a converter for raising the potential of the dynamo-electric current, and from this converter to supply the other converters in the system; the same idea is thrown out by Ferranti in the specification hereinbefore referred to. Neither of these proposals have been put into practice, in fact, no plan or method of carrying out the idea is described or claimed in either specification.

In 1886, I, with another, took this system in hand, and after a searching examination and practical testing adopted the arrangement illustrated in Fig. 3, which supplies electric energy from two large transformers to a three wire system; we may add another transformer and have four wires, and thus form a network of supply wires. The large transformers are preferably of a new type, which shall be explained under the head of "Transformers;" they raise the pressure from 50 volts to 2,000 volts, or 1,000 volts with a loss of less than 2 per cent., and they are fed from one or more dynamos.

FIG. 2.



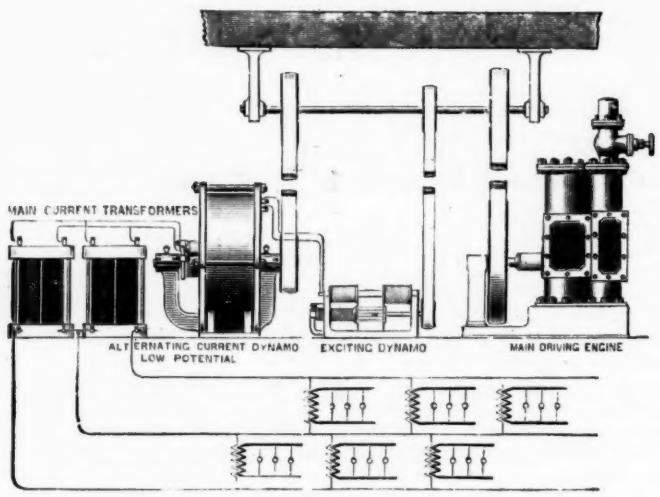


FIG. 3.

It may be thought at first sight that the use of transformers to raise the pressure is somewhat like the fifth wheel to a cart, but we have reason to believe that there is more loss and less reliability in high pressure alternating current generators than there is in a combination of a converter with a low pressure alternating current dynamo-electric generator.

This completes the list of published specifications in Britain. In America the subject is just now attracting considerable attention; Gaulard and Gibbs having

obtained a patent there for parallel connection. The current year will no doubt bring forward further developments, and by the end of it no doubt the parallel system will be in full swing on a large scale in this country as well as abroad.

(*To be continued.*)

THE UPWARD BATTERY (NEW TYPE).

WE have this week inspected one of the new type Upward batteries, as improved by the inventor. The apparatus is installed in a small recess in a cellar in the basement of No. 11, Queen Victoria Street, and is used for lighting Messrs. Woodhouse and Rawson's offices. We noticed that although there was absolutely no ventilation in the cellar, there was not the slightest trace of smell of chlorine.

The chemical basis of the battery, with all the advantages substantiated by Dr. Oliver Lodge, of course remains the same; the marked improvement of the new type relates mainly to great simplification. The battery is arranged as follows:—The generator is connected directly to the bottom of the first cell, the top of the first cell to the bottom of the second, as shown in the figure, and the top of the second to the bottom of the column gas holder, so that the generator, the two cells, and the gas holder are all in simple series. When the generator is at work the chlorine entering at the bottom of each vessel gradually displaces the whole of the air, so that when the retort has finished working the cells and gas holder are full of practically pure chlorine gas. When the circuit is closed each equivalent of chlorine used by the two primary cells is instantly supplied from the gas columns by the natural chemical absorption until the whole of the gas contained in the columns is used.

It will be seen that this method entirely does away with the artificial means of supplying the cells by the suction of the electrically-controlled aspirator. Having obtained this great simplification of gas supply, and using only two or three large cells as described, the next difficulty was to charge the accumulators with this arrangement, and the inventor solved the problem in the following manner. All the secondary cells are connected permanently in series with the lighting circuit, and one wire from each cell is brought to an automatic switch, which consists of a long roller which is freed at intervals of half-an-hour, or any other convenient time, each advance connecting the terminals of the primary battery with the next single secondary cell. This switch works automatically day and night until the whole set of secondary cells are completely charged, so that by this arrangement the primary battery of, say, two or three large cells, uniformly charges the secondary battery without the latter ever being connected in parallel, which, among other great disadvantages, would prevent the light being available at any hour. The new retort (fig. 2), will no doubt be well understood from the sketch. The perforated earthenware tray contains sufficient manganese for, say, a fortnight or three weeks' run; the daily charge of acid being admitted by the inlet at the side, which is now independent of the cover. The spent liquid of the previous day's work is allowed to run away by a sealed pipe, connected with the drain at one end and with the tap of the retort at the other. By this means the removal and emptying out of the contents of the retort are done away with; the acid itself is never handled, simply entering the retort from the graduated store jar by a closed pipe. When it is necessary to change the manganese (a fortnightly or three weekly operation) the retort is flushed out by water entering at the same aperture as the acid, this removing every trace of chlorine; the lid and the tray of spent manganese are then removed and the spare tray of fresh manganese inserted, and the lid replaced. We may add that the spent manganese can be reconverted to the peroxide form for use again at a cost which is almost nominal. The daily attention required by the battery is reduced to winding the clock and opening two taps, one in the retort, which lets out the spent liquid of the previous day, and the other at the bottom of the store jar, which admits the fresh charge of acid.

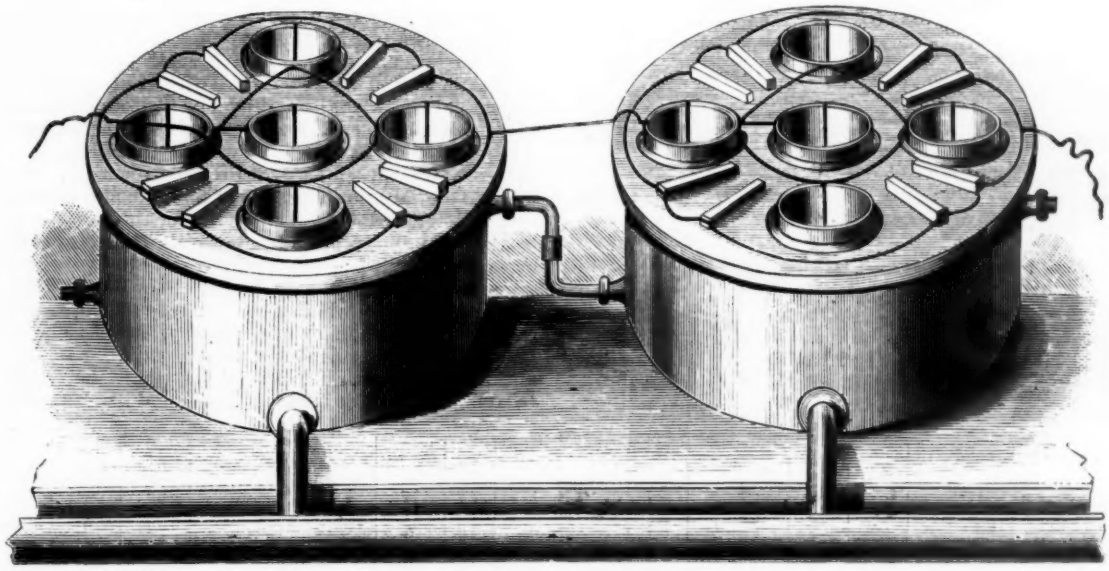


FIG. 1.—UPWARD PRIMARY CELLS. ZINCS CONNECTED IN PARALLEL. CARBONS DO.

Experiments on a practical scale are now being made to determine precisely the cost of maintenance, and from the accompanying table which has been issued by the manufacturers much information of a practical nature may be obtained; further particulars will doubtless be supplied to those in quest thereof by Messrs. Woodhouse and Rawson.

Mr. Upward's original battery and its various adjuncts have been very completely described and illustrated in the REVIEW, and those who are desirous of becoming acquainted with the inventor's *modus operandi* we would refer to our issue of June 25th, 1886. With this and our present number before him

a reader may become thoroughly conversant with Mr. Upward's clever devices, which more than ever commend themselves to practical uses. The favourable opinions which we have previously expressed respecting this battery we again endorse, for the objections which were raised against the employment of the apparatus in its primitive form appear to have been entirely overcome.

Even Mr. Sydney F. Walker would now probably admit that it can be readily handled by any ordinary

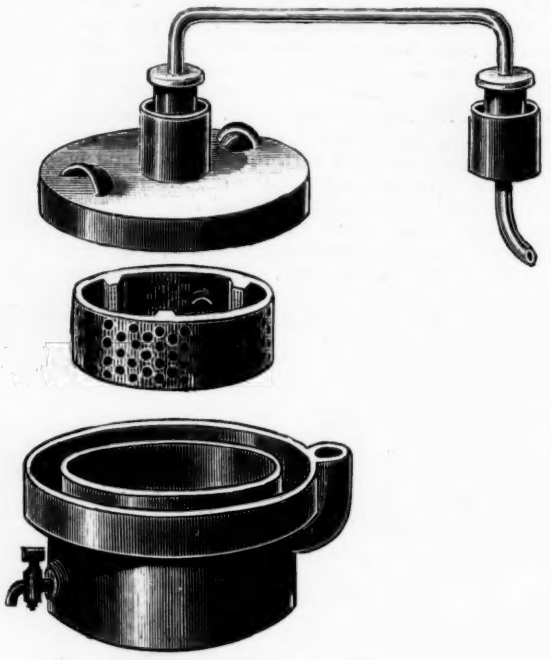


FIG. 2.

domestic possessed of average intelligence; and, indeed, it is difficult to imagine anything more simple. Mr. Upward has evidently considered most carefully every criticism which was levelled against him, and the result is a surprising example of what can be achieved by matured thought and directing attention to little details, which in this case have been reduced from complication to simplicity itself.

The Telephone and the Police Service.—The telephone is being introduced into the Glasgow police service instead of Wheatstone's ABC telegraph instruments.

THE LIGHTING OF THE BRIGHTON PAVILION.

WE understand that the Brighton Electric Light Company, Limited, has forwarded to the Corporation a tender for the lighting of the Brighton Pavilion. In his explanatory letter, the manager, Mr. Arthur Wright, states that the company is prepared to supply electricity at a fixed price, viz., ½d. per lamp per hour, and to put the whole installation in order, to the satisfaction of the fire insurance inspector, for the sum of £480. He points out that from the figures obtained of the cost of lighting the Pavilion for the two years ending September 30th, 1885, it can be seen that the total cost was £1,849 for 838,900 lamp hours, showing a cost of over ½d. per lamp per hour. This calculation was, however, based upon an allowance for depreciation of only 6 per cent., which the company, from experience, thought was very greatly under the mark, as all engines and electrical machinery depreciated at a far higher rate, nearer 15 per cent. than six. Its offer of ½d. per hour per lamp would include keeping the installation in repair, replacing broken lamps, providing a qualified electrician to take charge of the installation during the whole time that it was running, and supplying light whenever it was wanted up to any hour and for any number of lamps. The engines would always be running after dark, so that it would only be necessary for the switches to be turned on in order to procure light. The system used would be similar to that in vogue at the Town Hall, Eastbourne, which had met with the approval of the local authorities and of Mr. Preece. The company's tender for putting the installation in order, it was further pointed out, was considerably under Mr. Preece's estimate, which, exclusive of accumulators, came to £700, and including accumulators, £1,360. In paying for the electric light by the lamp, hour, or meter, the following great advantages were gained :—(1) The cost would always be the same per lamp per hour, whether 10 or 9 or 900 lamps were being run; whereas in the case of the Corporation supplying their own electricity, the cost per lamp hour increased enormously as the number of lamps alight diminished. (2) The light would be supplied by a company whose business it was, and had been for the last six years, to establish and maintain electric light installations, and who had therefore had a wide experience in these matters. (3) The removal of the nuisance of a high pressure steam engine working in the principal part of the town. (4) The removal from the shoulders of the Pavilion Committee of all responsibility in regard to the purchase of electrical plant which, owing to the rapid progress of science was being rapidly improved. The company naturally, for its own benefit, would make use of the most efficient and perfect electrical

Total number of lamps on installation.	Number of cells required at £9 each.	Accumulators charged by battery are capable of giving each day.		Number of columns at 25s. each, and weighing 2 cwt. each, required for gas holder.	Store jar and retort for chlorine, weighing 2½ cwt.	Number and cost of accumulator cells for use with battery, weighing 96 lbs. to 257 lbs. each, according to capacity.		Special charging switch for use with accumulators.	Approximate floor space required by combined battery and accumulators.	Approximate total weight of plant, including accumulators.	Rate in ampères beyond which current must not be taken off.	Maximum number of lamps of 10 C.P., which may be run simultaneously. If the lighting be required for longer periods, the number of lamps must be proportionately reduced.	Cost of equipment, including battery, accumulators, columns, acid jar, retort and charging switch.	Cost of lamps, leads, wire, small switches, safety cut-outs, &c., approximate.	Remarks.
	Weight 3C 3Q.	Watt hours.	10 C.P. lamp hrs.		£ s.	£ s.		£ s.	Ft. Ft. Ft.	Cwt.	Amps.	Hrs. Hrs.	£		
22	2 cells	700	22	4	10 10	8	16 16	6 10	12 × 4 × 9 high	25	22	11 for 2 or 6 for 4	56		
30	4 „	1,400	44	8	„	10	22 0	„	15 × 4 × 9 „	42	22	15 „ 3 „ 8 „ 6	84	About	
40	6 „	2,100	70	12	„	12	30 0	„	18 × 5 × 9 „	60	30	20 „ 3½ „ 10 „ 7	115	17s. 6d.	
60	8 „	2,800	93	16	„	12	30 0	„	21 × 6 × 9 „	76	46	31 „ 3 „ 15 „ 6½	137	per	
80	10 „	3,500	116	20	„	10	45 0	„	27 × 7 × 9 „	97	60	40 „ 3 „ 20 „ 6	175	lamp.	
100	12 „	4,200	140	24	„	12	60 0	„	30 × 8 × 9 „	117	74	50 „ 3 „ 25 „ 6	214		

The lamps specified are assumed to be all of 10 C.P., taking 30 watts—if 5 C.P. are used double the number can be installed.

plant. (5) The electricity would be generated by very powerful compound engines, whose excellent governing powers would ensure the steadiness of the light, while the engines being duplicated a breakdown would be rendered almost impossible. In fact, the lighting would be as certain as though it were done by storage batteries, and would be 40 or 50 per cent. cheaper. In conclusion, the company suggested the advisability of selling the existing electrical plant, including engines, dynamos, and belts, and out of the money so obtained there would be ample to pay for repairs to the installation.

NOTE ON INDUCTION COILS OR TRANSFORMERS.*

By JOHN HOPKINSON, M.A., D.Sc., F.R.S.

THE transformers considered are those having a continuous iron magnetic circuit of uniform section.†

Let A be area of section of the core.
m and n the number of convolutions of the primary and secondary coils respectively,
R, r, and ρ their resistances, ρ being the resistance of the secondary external to the transformer,
x and y currents in the two coils,
a induction per square centimetre,
α the magnetic force,
l the length of the magnetic circuit,
$E = B \sin. 2\pi (t/T)$, the difference of potentials between the extremities of the primary,
T being the periodic time.

We have

$$4\pi (m x + n y) = \alpha ; \quad (1)$$

$$E = R x - m A \dot{a} ; \quad (2)$$

$$0 = (r + \rho) y - n A \dot{a} ; \quad (3)$$

from (2) and (3),

$$n E = n R x - m (r + \rho) \quad (4)$$

substituting from (1),

$$x \{ n^2 R + m^2 (r + \rho) \} = n^2 E + (l a / 4\pi) m (r + \rho) ; \quad (5)$$

$$y \{ n^2 R + m^2 (r + \rho) \} = - n m E + (l a / 4\pi) n R ; \quad (6)$$

$$A \dot{a} = - \frac{(r + \rho) m E}{n^2 R + m^2 (r + \rho)} + \frac{l a R (r + \rho)}{4\pi \{ n^2 R + m^2 (r + \rho) \}} . \quad (7)$$

We may now advantageously make a first approximation, neglect $l a$ in comparison with $4\pi m x$, that is, assume the permeability to be very large, we have

$$A \dot{a} = - \frac{(r + \rho) m B \sin (2\pi t/T)}{n^2 R + m^2 (r + \rho)} ; \quad (8)$$

$$A a = \frac{(r + \rho) m B \cos (2\pi t/T)}{\{ n^2 R + m^2 (r + \rho) \} . 2\pi/T} . \quad (9)$$

For practical purposes these equations are really sufficient.

We see firstly that the transformer transforms the potential in the ratio n/m, and adds to the external resistance of the secondary circuit ρ a resistance $(n^2 R/m^2) + r$. This at once gives us the variation of potential caused by varying the number of lamps used. The phase of the secondary current is exactly opposite to that of the primary.

In designing a transformer it is particularly necessary to take note of equation (9), for the assumption is that a is limited so that $l a$ may be neglected. The greatest value of a is $B/\{ (2\pi/T) m A \}$, and this must not exceed a chosen value. We observe that B varies as the number of reversals of the primary current per unit of time.

But this first approximation, though enough for practical work, gives no account of what happens when transformers are worked so that the iron is nearly saturated, or how energy is wasted in the iron core by the continual reversal of its magnetism. The amount of such waste is easily estimated from Ewing's results when the extreme value of a is known, but it is more instructive to proceed to a second approximation, and see how the magnetic properties of the iron affect the value and phase of x and y. We shall as a second approximation substitute in equations (5) (6) (7) values of a deduced from the value of a furnished by the first approximation in equation (9).

In the accompanying diagram o x represents a, o y represents a, and o z the time t.

The curves, A, B, C, D, represent the relations of a and a. E, F, G, the induction a as a function of the time, and H, I, K, the deduced relation between a and t. We may substitute the values of a obtained from this curve in equations (5) and (6), and so obtain the values of x and y to a higher degree of approximation. If the

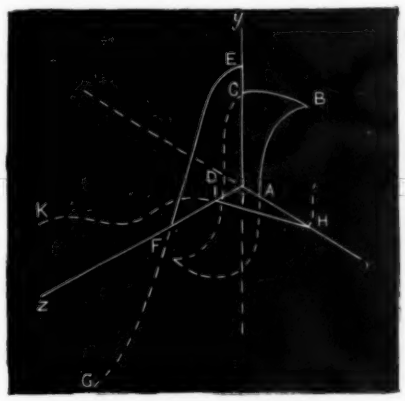


FIG. 1.

values of a were expressed by Fourier's theorem in terms of the time, we should find that the action of the iron core introduced into the expression for x and y, in addition to a term in $\cos (2\pi t/T)$ which would occur if a and a were proportional terms in $\sin (2\pi t/T)$ and terms in sines and cosines of multiples of $2\pi t/T$. It is through the term in $\sin (2\pi t/T)$ that the loss of energy by hysteresis comes in.

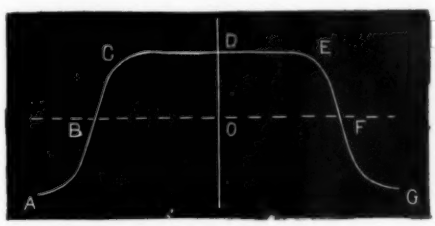


FIG. 2.

A particular case in which to stay at a first approximation would be very misleading is worthy of note. Let an attempt be made to ascertain the highest possible values of a by using upon a transformer a very large primary current and measuring the consequent mean square of potential in the secondary circuit, by means of an electrometer, by heating of a conductor, or other such device. The value of a will be related to the time somewhat as indicated by A, B, C, D, E, F, G, in fig. 2; for simplicity assume it

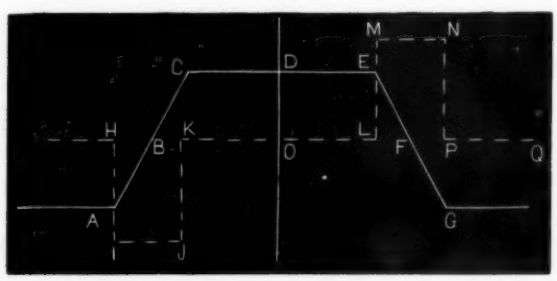


FIG. 3.

be as in fig. 3, the resulting relations of potential in the secondary and the time by the dotted line, H, I, J, K, O, L, M, N, P, Q. The mean square observed will be proportional to M, L., L, P, but M, L., L, P, is proportional to E, L, hence the potential observed will vary inversely as L, P, even though the maximum induction remain constant. If then the maximum induction be deduced on the assumption that the induction is a simple harmonic function of the time, results may readily be obtained vastly in excess of the truth.

* Read at a meeting of the Royal Society, March 10th, 1887.

† For a discussion of transformers in which there is a considerable gap in the magnetic circuit, see Ferraris, *Torino, Accad. Sci. Mem.*, vol. xxxvii., 1885, Hopkinson, "On the Theory of Alternate Currents," *Telegr. Engin. Journ.*, vol. xiii., 1884, p. 496.

NOTES.

Train Lighting.—Experiments are shortly to be made, *Industries* states, with a view to the introduction of the electric light into railway carriages in India. Owing to the large distances to be traversed in India, night journeys are a necessity; in fact, by reason of the comparative coolness of night travelling, many people prefer trains which run after dark. The carriages are now lighted by the old fashioned oil lamps, which give only a dim light, and often no light at all when the railway servants omit to trim them.

Electric Lighting in the City.—Col. Haywood's report of the works executed by the Commission of Sewers for the City of London during the year 1886, states that the proposal for lighting a large area of the City made by the Brush Corporation was under consideration, and a report upon it obtained from Mr. W. H. Preece, F.R.S., but up to the present time nothing definite has been settled. During the year no part of the public ways, nor any of the City bridges, were lighted by electricity.

Electric Lighting in Glasgow.—The Corporation of Glasgow is advertising for plans and tenders for supplying and fitting up the necessary engines, dynamos, wires, &c., for lighting a portion of the new Municipal Buildings and the City Hall and Bazaar. Further information may be obtained as regards the former from Mr. William Young, architect, 1, Lancaster Place, Strand, London, and as regards the City Hall and Bazaar from Mr. John Carrick, City Architect, Glasgow. Plans of tenders must be lodged on or before the 23rd proximo.

Electric Lighting at Eastbourne. — On Tuesday evening the Mayor of Brighton and over 30 members of the Town Council paid a visit to the Eastbourne Town Hall, in order to inspect the electric lighting installation which has been most successfully carried out on a large scale by the local company. They were accompanied by Mr. Robert Hammond, chairman of the Brighton Electric Light Company, which has just made an offer to the Corporation, as reported in the ELECTRICAL REVIEW, to supply the Brighton Pavilion with a similar installation on favourable terms. Altogether 384 Swan incandescent lamps, each of 16 C.P., are used in lighting the Town Hall, these being governed by switches. The current is supplied from the central lighting station of the company in Junction Road, where there are three engines of 55 H.P. each, two Brush dynamos, one spare Brush, and one alternating dynamo. In the large hall, used for public meetings, &c., there are 14 pendants, each having 10 lights, in addition to smaller lamps on either side of the platform. The company only charges one half-penny per lamp per hour. Mr. Hammond told the visitors that the Eastbourne Town Hall had been lighted on a new principle, which he believed would eventually obtain a very general application. The progress of electric lighting at Eastbourne has been most considerable of late, thanks principally to the energy of the Electric Light Company which has been established there. Besides the Town Hall there are installations at St. Saviour's Church, Queen's Hotel, Gildridge Hotel, and several private houses.

The Paddington Installation.—In the action brought by residents in the neighbourhood of Paddington Station against the Great Western Railway Company, with reference to the noise and vibration caused by the electric lighting machinery, Mr. Justice North, on Wednesday, said he had himself paid a visit to the locality, and had come to the conclusion that the plaintiffs' witnesses had exaggerated the nuisance. There was no appreciable discomfort or nuisance, and he refused the motion, which was that a writ of sequestration should be issued against the company for breach of an injunction. Plaintiffs were, however, allowed their costs.

Electric Lighting of a Railway.—A bill has been introduced in the New York Legislature with the object of compelling the New York elevated railroad companies to place electric lights along their tracks at intervals of 300 feet.

The Telephone on War Vessels.—Last week a trial was made of the machinery of the *Camperdown*, one of the new "Admiral" class of battle ships. During the day the United Telephone Company experimented with an instrument for communicating between the bridge and the engine room. The ordinary voice pipe is impracticable in consequence of the noise produced by the machinery, and a committee has been appointed to consider how the difficulty can be surmounted. The telephonic instrument employed enabled the orders to be heard distinctly while the engines were working at their greatest power, and was favourably received by the officers on board.

The Sultan and the Cable.—A Reuter's telegram, dated Tangier, March 18th, says there is no truth in the report published by a Ceuta journal last week, that the Sultan of Morocco had ordered the cutting of the cable recently laid between Tangier and Europe.

The Telephone in India.—Mr. Killingworth Hedges, writing to *Industries* upon this subject, says that the telephone has proved a great success in India, although the early days of the industry were not "plain sailing," the Government having opposed the erection of telephone lines, whilst it still interferes with the development of telephonic communication on grounds similar to those taken up by the English Post Office. The Oriental Telephone Company introduced the instrument in the country, and has now subsidiary companies running at Bombay, Calcutta, Madras, and Kurrachee. The Bombay Company has 350 subscribers, the charges being:—for merchants, banks and mills, £15; for shopkeepers, £12; and for private use, £7 15s. per annum. At call-boxes, of which there are eight in Bombay, occasional conversations may be had at a charge of two annas, or about 2¼d., reckoning the rupee at 1s. 6d. The Blake transmitter and the Gower-Bell receiver are employed, and the wires are principally of phosphor bronze, 17 B.W.G.

The Effect of the Electric Light on the Eye.—According to the opinion maintained by many eminent authorities the effect of the electric light on the eye is very injurious, although it is admitted that as yet no case of deterioration of eyesight through this agency has been absolutely proved, the cases reported being more or less doubtful. Lately however several foreign oculists of note have given the subject special attention and effected some interesting experiments. Among these is the celebrated student of colour-blindness, Prof. Cohn, of Breslau, who has come to the conclusion that the electric light is rather beneficial than injurious to the eye. Thus his experiments appear to show that eyes which could not distinguish certain colours by day or gas light did so by the electric light. Compared with daylight he finds that the electric light doubles the capability of distinguishing green and blue, increases six times the capability of recognising red, and even sixty times that of yellow. As is generally known, diffused daylight, not sunshine, never dazzles the eye on account of the source whence the light emanates being veiled to the eye. Consequently, the hygiene of the eye demands a light the dazzling rays of which do not strike the eyeball straight, and also that the source of the light be hidden. In connection with this subject it may be of interest to mention that the eminent French physician, M. de Javal, considers that there is never too much nor sufficient artificial light. On the other hand, Prof. Cohn is of opinion that prismatic shades are the most economical and pleasant for electric lighting, by absorbing the least light and diffusing it the most evenly.

The Blenheim Telephone.—We had an opportunity a few days since of trying the working of the telephone exchange fitted up at the new infirmary for St. Saviour's Union at East Dulwich. The fixing has been done by Mr. J. Coles, of 1, Barlborough Street, New Cross. There are twenty lines affording communication between the lodge, where the indicator is fixed, and the medical superintendent's office, his house, the steward's office, and the various wards. Conversation can also be held between any two of these points, the indicator showing to the attendant whether it has begun, whether it is still continued, and whether it is closed. The apparatus appeared to be equal to any demand likely to be made upon it, the articulation being very distinct, and the manipulation as simple as possible. We are informed that lines of a similar nature have been fitted at the Surrey County Asylum, Brookwood; the Sanatorium, Virginia Water; and the Royal Holloway College, Egham. A double exchange is in course of construction at the new Lancaster County Lunatic Asylum, Rainhill.

The Production of Light.—A lecture was delivered on the 17th inst. before the Forest Hill Scientific Society, by W. Stepney Rawson, M.A., the subject being "Light and its various modes of production." A large number of interesting apparatus was shown, amongst which we may mention a thermo-pile of Prof. Forbes's pattern, and made by Messrs. Nalder Brothers; also the latest form of the pentane lamp of Mr. Vernon Harcourt, which was used to illustrate various modes of photometry, and was described as supplying a great want, namely, a reliable standard of light. A method of photometry by reduction of the stronger light by means of rotating discs was explained, and allusion made to Abney's and Festing's photometry of coloured lights. In illustration of the most modern developments of gas lighting, the lecturer showed one of the Welsbach incandescence lamps, the light of which had been measured as being 18½ candles, while the burner consumed only $2\frac{3}{10}$ cubic feet of gas per hour, an efficiency which had even been exceeded in practice with this type of burner. A new method of lighting and controlling gas burners at a distance by means of electro-magnets worked similarly to electric bells, was shown in action. The latter part of the lecture was concerned with the production of light by electricity. The enormous light produced by arc lights had proved of great practical value in lighthouse work, and would certainly lead to the more general adoption of them, since their superiority had been so completely established by the experiments at the South Foreland. Many interesting applications of incandescent lamps were shown, and the working of the Upward battery for house installations was explained, and Dr. Oliver Lodge's opinion quoted with reference to it as being the first really practical battery for lighting purposes. The whole of the apparatus was supplied by Messrs. Woodhouse and Rawson.

Polytechnic Institute.—At the distribution of prizes and certificates to the successful students of the Polytechnic Science, Art, Technical, and Commercial classes, and to the successful exhibitors at the annual exhibition on the 16th, at which the Marquis of Hartington presided, Mr. W. T. Paton, one of the secretaries, read some statistics showing that the number of students who in 1883 were 3,200 rose in 1884 to 5,519, in 1885 to 5,656, and in 1886 to 6,875, totals which justified him in saying that the Polytechnic occupied at present the first place amongst similar institutions, either in the United Kingdom or America.

Electric Tramways for Philadelphia.—It is reported that the Philadelphia Traction Company has finally and successfully experimented with electricity as a motive power for its cars. Motors are said to have been already put in a number of the cars, and are to supersede the cable in the spring. By degrees, if the new motor comes up to expectation, it will be gradually introduced over the whole system.

Safety Valves.—Messrs. Turnbull & Co., of Glasgow, have sent us an illustrated sheet of some of their manufactures in the way of safety valves, showing the various forms in which they are made to suit varying requirements. It is stated that of the exhibitors at the recent Edinburgh Exhibition, no less than 40 were users of these Turnbull valves. The sheet is an exceptionally good one in the matter of engraving, arranging, and printing, and we presume the firm would supply a copy to any one sufficiently interested to apply for it.

Newcastle-on-Tyne Mining Exhibition.—An important feature of this exhibition, which is announced to open on May 11th, will be the installation of several forms of endless rope and other means of haulage. All the systems will be of full size shown at work, and are expected to prove of interest to all engaged in mining operations. Electric motors will supply the power to some of the systems, steam and compressed air being applied in other cases.

Technical Education.—Mr. Edward Cookeworthy Robins, F.S.A., whose collected papers on Technical Education and Applied Science, Buildings, and Fittings, &c., were reviewed in *Nature* some time ago, is now engaged on a general work of reference on the same subject. It will appear shortly under the title of "Technical School and College Buildings," in a quarto volume of about 250 pages, with upwards of 100 full page illustrations, plates, and maps.

Partnership.—Messrs. Thompson and Ritchie have taken into partnership, Mr. Robert Thorburn Turnbull, who has for some time been with them in the capacity of engineer, and, henceforth, the name of the firm will be Thompson, Ritchie & Co.

Tenders Wanted.—The Lancashire and Yorkshire Railway Company invites tenders for telegraph fittings, telegraph wire, and wire to be sent to the Secretary, Hunt's Bank, Manchester, before the 4th of April.

Liverpool Imperial Jubilee Exhibition.—It is intended to resuscitate the Liverpool Exhibition with the above designation, and to re-open in May next. The object is to pourtray in a practical manner the victories of peace and war during her Majesty's reign. Electrical engineering will have its place in the machinery court, old appliances being shown side by side with new, in order to fully illustrate its history. The whole of the building and grounds are to be illuminated by electric light, and arc lights will be dispersed among the trees in the grounds.

Electric Locomotion.—We are informed that Mr. Reckenzaun's paper on "Electric Locomotion," which was announced to be read on the 30th inst., before the Society of Arts, is postponed till after Easter.

The Electrical Power Storage Company.—We would call attention to the report of the Electrical Power Storage Company, which may be found amongst our City Notes. It would be interesting to know what proportion of the profit of nearly £36,000 is due to the working of the year and how much to marketable interests? Independently of this, however, the business of the company appears to be remarkably good and its prospects for the future decidedly bright. The directors are certainly to be congratulated on the success which has attended their exertions and we wish the company prosperity. This indeed may be considered almost assured, for every year will see an increased demand for secondary batteries.

Snow and the Wires.—In consequence of heavy snowstorms, Trieste was during a portion of last week completely cut off from communication with the rest of the Empire by rail and telegraph.

New Dynamos.—We have recently had an opportunity of inspecting some of the latest dynamos made by Messrs. Crompton & Co., and note that the type is undergoing modification. The length of armature core is about five times its radial depth instead of 10 times as was formerly the practice. The former proportion agrees closely with that of the double magnet type of "Phœnix" machines made by Messrs. Paterson and Cooper, and it is interesting to note that while one firm has shortened up the armature core the other has lengthened it out until the same proportion has been reached. Mr. Crompton, we understand, designs dynamos with his "eye," but we hesitate to ascribe to structural modifications in this valuable organ, the recent modifications in his dynamo.

Ayrtonian.—Prof. Ayrton enjoys among his students a reputation for the invention of perfect fitting metaphor. Every old student can relate some instance in which facts have been emphasised and preconceived notions crushed down under the weight of forcible analogy. Now his method is compared to that of the man "who hires a brewer's dray to carry a postage stamp," then he has the misfortune to resemble "a jockey who rides three times round the course to give his horse exercise before the race commences." The comparison may be extravagant, it is none the less effective, and the smile raised by it is the sickly smile of a man who wonders how he didn't see such a simple thing before. But it is not of Prof. Ayrton's success as a teacher that we would speak, these thoughts merely having been occasioned by his remarks at the Society of Telegraph-Engineers last week. Speaking of secondary batteries, Prof. Ayrton could not understand the considerations which had prompted manufacturers to class cells as being equal to so many horse-power hours. The description gave no idea of what the cells could do. As a matter of fact, a horse-power cell didn't give out energy at the rate of a horse-power or anything like it. If a man went to buy a watch it might be said that while his money passed over the counter he lived up to £100,000 a year for a minute, but it did not follow that his income was £100,000 nor was it true that a horse-power hour cell would give out one horse-power for an hour. The term was most misleading and should be abandoned.

Removal.—On the 24th inst. the offices of Messrs. W. T. Henley's Telegraph Works Company, Limited, will be removed from 8, Drapers' Gardens, E.C., to 27, Martin's Lane, Cannon Street, London, E.C.

Technical Institute for Dundee.—According to the amended scheme for carrying out the purposes of the Baxter bequest which has just been published, ample provision is to be made for the study of electricity in the new Technical Institute about to be established in Dundee, the plan of the building embracing an electrical laboratory on the ground floor and another on the basement, which are to be fitted up with every requisite for the efficient carrying on of the work of classes learning the practical applications of this science.

Monster Switch Board. — Messrs. Sudworth and Falkenstein have just completed a very fine piece of workmanship in the shape of a switch board to be used at Northumberland Avenue Hotel, which is now being fitted for the electric light by Messrs. Thompson and Ritchie. The base of the switch board is of course of slate, that material being now almost the only one used for such purposes. It is 5 feet 6 inches high and 4 feet 8 inches wide, and the massive character of the fittings may be judged from the fact that the main accumulator switch, which is 16 inches in diameter, weighs 1 cwt., and is capable of dealing with a current of 1,000 ampères. In addition there are four two-way ground switches and one three-way ground switch as well as the usual cut-outs, meters, and other accessories. Messrs. Sudworth and Falkenstein make a speciality of switches, and are introducing some new arrangements.

The Proposed Electric Launch Competition.—"Electra," writing to the *North British Daily Mail* in reference to the proposed race across the Channel, mentioned in the REVIEW of the 11th inst., says:—"It occurs to me this could be improved in importance—both as an actual test of what can be done in this way, and at the same time give an impetus to this branch of business if, instead of only two contesting, it were made open to all comers who have electric launches, thereby showing which system is best, as there seems considerable doubt on this point. I doubt not some of those gentlemen interested in electric matters would be willing to subscribe a small sum by way of giving a prize to the winner; also, being the jubilee year of our Queen, the race might be arranged for in honour of this event. I make this suggestion in the hope that it may meet the eye of those interested, and would be willing to do what little I could to further it."

The Incandescent Gas Light.—The *Financial News* enthusiastically hails the advent of the Welsbach incandescent gas burner, and speaks of it as "The Coming Light," and as "an electric light without electricity, costing only a few pence where an electric light would cost pounds."

Electrical Communication with Light-Vessels.—A meeting of the committee appointed to consider the subject of electrical communication between lightships and the shore was held at the offices of the Board of Trade on Monday. The Earl of Crawford presided, and there were present Colonel King-Harman, M.P., Sir E. Birkbeck, M.P., Mr. T. Sutherland, M.P., Captain Webb, Colonel Hozier, Sir George Nares, and Mr. Trevor. Evidence was given by Mr. Emmerson, Superintendent of Trinity House for the Great Yarmouth district; Mr. Whilby, mate of the *St. Nicholas* light-vessel; Mr. Jenkins, mate of the *Gull* light-vessel: and Captain Glover, Harwich.

City and Guilds of London Institute.—In a circular recently issued it is stated that the Central Institution at South Kensington, though erected at less than a third of the cost of the Technical High School at Berlin, is now replete with all the appliances for the education of technical teachers, and of persons who are training with the view of becoming mechanical, civil, or electrical engineers, or master builders, or of taking the management of works in connection with any of our great chemical and other manufacturing industries. The advantages offered by the Central Institution enable parents to secure in London for their sons technical instruction of the same high class as has been for so many years provided in the great Technical Colleges of the Continent, and better adapted to the special circumstance of home industry; and it is hoped that students trained in the Central Institution will gradually occupy the places in manufacturing works, and especially in chemical works, both in Great Britain and in the Colonies, which now for some years have been almost monopolised by the Germans and the Swiss. The number of students now receiving instruction in the institution is 258. A course of practical lessons in chemistry for teachers in public elementary schools, by Prof. Armstrong, will commence on Saturday, April 30th. There are already 230 applications for admission. Prof. Ayrton commences in July next a series of lectures and practical demonstrations in the testing of dynamos and motors. The matriculation examination for students wishing to enter upon a three years' course, with a view of qualifying for the diploma of the Institute, will be held on the 27th September, and on the three following days. The fees for matriculated students are £25 per annum, payable in advance; for students working in one department only, £20 per annum, payable in advance; for other students working all day throughout the week, £10 per term, or less, according to the number of hours the student works.

NEW COMPANIES REGISTERED.

Cadogan Electric Light Company, Limited.—Capital: £30,000 in £5 shares. Objects: To enter into contracts for electric lighting and for the supply of electric energy. Signatories: J. Sayer (engineer), 25, Norfolk Road, Brighton; B. Verity, jun. (gas engineer), 177, Regent Street, 5 shares each; S. Haynes, 60, Fernlea Road, Balham; C. White, 36, Knowle Road, Brixton; F. Fawkes, 33, Denzil Road, Neasden, N.W.; J. W. Humphry, Hanwell; Wm. Webb, 11, Austin Friars. The signatories are to appoint the first directors. Qualification: 20 shares. Remuneration: £150 per annum. Registered 21st inst. by Messrs. George and Wm. Webb, 11, Austin Friars.

Strand Electric Lighting Company, Limited.—Capital: £30,000 in £5 shares. Objects: To generate and supply electricity, electric light, and power for public and private use within the Strand district, the parish of St. Martin-in-the-Fields, and elsewhere in the metropolis. Signatories (with 1 share each): J. Coles, 88, Tresellian Road, St. John's; S. C. Hannah, 49, Walterton Road, W.; P. G. Ebbutt, Croydon; A. O. Paulsen, 51, Welbeck Street; *J. B. Verity (electrical engineer), Weybridge; S. C. Hastings, 31, King Street, Covent Garden; *J. V. Whitaker, 12, Warwick Lane, E.C. Mr. J. S. Crace Cunnington and the signatories denoted by an asterisk are the first directors. Qualification: 10 shares. Remuneration: £200 per annum to the chairman, and £100 per annum to each ordinary director. Registered 19th inst. by Messrs. Lewin & Co., 32, Southampton Street, Strand.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Telephone Company of Egypt, Limited.—The annual return of this company, made up to the 15th inst., was filed on the 19th inst. The nominal capital is £100,000, divided into 16,000 preferred and 4,000 deferred shares of £5 each. 12,071 preferred and the whole of the deferred shares have been taken up, and the full amount has been called thereupon. £80,000 is considered as paid upon 12,000 preferred and 4,000 deferred, and the sum of £355 has been received in respect of calls upon the remaining 71 preferred shares.

Patent Electric Fire Lighter Company, Limited.—The statutory return of this company, made up to the 17th inst., was filed on the 21st inst. The nominal capital is £3,000, in £1 shares. 1,400 are taken up, of which 700 are considered as fully-paid, and the full amount has been received by the company in respect of the remaining 700 shares. Registered office, the Works, Marshgate Lane, Stratford.

Fischer Electro Amalgamator Company, Limited.—The annual return of this company, made up to the 22nd October, 1886, was filed on the 19th inst. The nominal capital is £25,000, in £5 shares. 1,837 shares are taken up, and 1,500 of these are considered fully-paid; upon the remaining shares allotted the sum of £1,685 has been paid up. Registered office, 31, Queen Victoria Street.

Parker's Electric Wire Corporation, Limited.—The annual return of this company, made up to the 28th ult., was filed on the 16th inst. The nominal capital is £100,000, in £5 shares, of which 7,500 are issued as fully-paid. Upon 170 ordinary shares the full amount has been called up. The calls paid amount to £530 7s. 2d., leaving £4 12s. 10d. unpaid. Registered office, Palace Chambers, 9, Bridge Street, Westminster.

Jablochkoff and General Electricity Company, Limited.—An agreement, dated 14th inst. and filed on the 18th inst., provides for the payment to the company by Messrs. Edward Manville and Wm. Leonard Madgen of the sum of £1,000 as soon as certain special resolutions are passed and confirmed, a further sum of £1,000 at the expiration of nine months from the date of such confirmation, and a further sum of £500 at the expiration of two years from such date. In consideration of such payments the company will allot 90 fully-paid shares of £100 each. So long as any part of the said sum of £2,500 shall remain unpaid, Messrs. Manville and Madgen will pay over to the other shareholders the amount of the dividends upon 10 of such 90 shares by way of augmentation of dividend.

An extraordinary general meeting of the company was held at the offices, No. 36, Albert Embankment, on the 24th ult., when it was resolved that the name of the company be changed to "The United Electrical Engineering Company." Certain alterations were made in the articles of association, under which the borrowing powers of the directors are limited to £10,000, provided that the sum of £2,000 already borrowed from Messrs. Ainslie, Samuel and Metcalfe be part of such sum, and in lieu of the mortgage at present existing for securing the said £2,000 and interest thereon, the directors may issue mortgage debentures to secure the said sum and interest. Messrs. Manville and Madgen were appointed managing directors at a remuneration not exceeding £200 per annum each, and £25 each in respect of each 2½ per cent. dividend. The resolutions were duly confirmed on the 15th inst. and registered 18th inst.

Simplex Electric Light and Plant Company, Limited.—The annual return of this company made up to the 11th inst. was filed on the 17th inst. The nominal capital is £40,000 in £5 shares, 3,450 shares are taken up, 1,200 of which are considered fully paid. The calls paid amount to £11,250. Registered office, Valley Mill, Eccles, near Manchester.

Swan United Electric Light Company, Limited.—The annual return of this company made up to the 8th inst. was filed on the 16th inst. The nominal capital is £1,000,000 in £5 shares. The number of shares allotted is 80,000, upon which £3 10s. has been paid up, and 19,750 shares upon which £5 per share is paid up. The total of the calls paid is £377,983, and unpaid £781. The sum of £365 has been paid upon 146 shares forfeited.

Electro Metal Extracting, Refining, and Plating Company, Limited.—The office of this company is now situate at Hutchings Street, West Ferry Road, Millwall, E.

Central Stations.—We hear that exhaustive experiments are being made in Gothenburg, Sweden, in which several American companies are participating, with the view of establishing central stations for electric lighting.

CITY NOTES, REPORTS, MEETINGS, &c.

Electrical Power Storage Company, Limited.

THE directors' report for the year ending December 31st, 1886, states that the profit arrived at by the result of the working of the year and by certain interests becoming marketable is £35,937 11s. 3d.; the balance of profit and loss of 1885 amounted to £22,412 6s. 9d., which being deducted from the above profit leaves a balance of £13,525 4s. 6d. to the credit of profit and loss, which the directors propose to carry forward.

The shareholders will doubtless consider that the result of the operations of the past year is eminently satisfactory. The business of the company has increased, and a further great extension may be expected, if the Electric Lighting Act is amended, as proposed in the Bill now before the House of Lords.

The works have during the year been fully engaged in the manufacture of accumulators and sundry electrical apparatus, and in addition to cells of the lighting type, motive power batteries for electric launches, torpedo, and tramcar purposes have been successfully constructed.

The greater part of these are in use in England and have been supplied principally through the medium of electrical lighting companies and firms, with all of whom the company endeavours to maintain a friendly alliance.

Few installations are now erected in which the electrical power storage batteries do not play an important part. The motive power cells have been chiefly used in connection with electric launches. Among the notable incidents of the year 1886 are the

channel trip of the electric boat *Volta* and the public trials of the submarine boat *Nautilus*, in both of which this company's accumulators were employed.

The experience gained with these and other launches would indicate that electrical navigation must at an early date develop into a prominent industry. There is little doubt that in time the Admiralty will use electrical launches as part of the indispensable fittings of men-of-war which are now, with few exceptions, being fitted throughout with apparatus which is suitable for charging accumulators. These might be used for regulating and supplying the light in the vessel while the launch is hanging on the davits, which plan has been successfully adopted in the case of the launch supplied to the steam yacht *Northumbria* for his Grace the Duke of Bedford.

Many of Her Majesty's ships have been fitted with accumulators for working the light in conjunction with dynamos. More headway has, however, been made in this respect by the Danish and Italian Governments, more especially the latter, which was in a position to determine precisely the merits of storage batteries for ship use from the trial made with the cells placed on the *Giovanni Bausan* nearly three years ago.

The experiments conducted during the past three and-a-half years in train lighting, have proved thoroughly successful, as the Railway Electrical Contractors, Limited, have received orders for largely extended business on the London Brighton and South Coast Railway and other of the leading lines, and in consequence have commissioned the company to manufacture a considerable number of train lighting batteries.

As regards foreign and colonial work, the directors have to report that the large contract for 100 tons of accumulators, to be used in the extensive arrangement for central station lighting in Vienna, which the Imperial Continental Gas Association is undertaking, has been fulfilled.

The German Edison Company also use the company's batteries in connection with their lighting stations in Berlin. Many mills and warehouses on the Continent have adopted the batteries, and the trade house through whom these were supplied express themselves highly satisfied with the results obtained.

Several colonial governments are using the company's apparatus, and the users in the colonies are gradually becoming aware of the advantages of storage batteries.

In the home trade a substantial increase in the demand for the several types of cells is anticipated during the current year, as it is now a recognised fact among engineers, that no electric light installation is complete without storage batteries, and much attention is at last being given to the running of electrically propelled tramcars, which must increase the accumulator business in this direction.

The Folkestone Exhibition lighting, which was entirely carried out by this company, ran without the slightest interruption, giving great satisfaction to the authorities.

Many city offices have been lighted, among which may be mentioned those of the North British and Mercantile Insurance Company, English Bank of Rio de Janeiro, Union Bank of Australia, London and Brazilian Bank, the Leathersellers' Company, also numerous private residences. The lighting of the Prudential Assurance Company's offices with a plant suitable for 2,000 lamps was successfully accomplished in June last. The staff is now busily engaged upon several new installations.

The plant for temporary lighting of evening parties and balls has been increased to meet the demand for this class of lighting.

In the United States the Electrical Accumulator Company (in whose success this company is greatly interested), has, under the able management of its president, Mr. Theo. N. Vail, made rapid progress.

In addition to Elwell-Parker, Limited, the company has granted a license to manufacture under royalty, for certain specified purposes, to the Edison and Swan United Electric Light Company, Limited.

The directors have appointed Mr. Frank King, who has made a special study for several years past of secondary batteries and their use in central station lighting, to the post of superintending engineer.

German Union Telegraph and Trust Company, Limited.

The ordinary general meeting of this company was held on Monday at Winchester House, Old Broad Street.

Sir James Anderson, who presided, said they had made £2,000 more in the past year than in the previous year, notwithstanding the fact that the tariff had been very low. That must be regarded as a very satisfactory circumstance: and another congratulatory feature was that they had a reserve of £67,700, in addition to £27,000 of capital unexpended. Their cable lay in shallow water along its whole track, rendering it unnecessary for them to keep a repairing steamer, which they could hire whenever it was necessary to do so. That was an advantage which no other cable company possessed; and, so far as one could speak of submarine cable property, theirs was, in his opinion, the most secure of any in existence. They had had no break last year, and not a single interruption. He concluded by moving the adoption of the report and the declaration of a dividend of 6s. 3d. per share, making, with the previous distribution, a total dividend for the year of 12s., or at the rate of 6 per cent per annum.

Mr. H. G. Erichsen seconded the motion, which was carried unanimously, and the retiring director and auditor were re-elected.

Direct Spanish Telegraph Company, Limited.

THE report of the directors for the half-year ended December 31st, 1886, states that after providing for debenture interest and for expenses in connexion with the reduction of the company's capital there remains a balance to the credit of profit and loss of £3,994.

Notwithstanding the reduction of tariff made at the Berlin Telegraph Conference of 1885, and which came into force on July 1st, 1886, the traffic receipts show an increase of £230 as compared with the corresponding half-year of 1885, and an increase of £320 as compared with the last half-year.

The new Bilbao cable and the Marseilles-Barcelona cable have continued in excellent working order throughout the half-year.

As notified to the shareholders by the circular of December 31st, 1886, the reduction of the company's capital came into force on January 1st last; the balance sheet is therefore based upon the capital as it originally stood. The directors propose to put £3,900 of the balance of profit and loss to the reserve fund, which would then amount to £18,577, and to carry £94 to the next account; but as £15,000 has been taken from the reserve fund since January 1st, to meet the payment of dividends and income-tax on preference shares for the five half-years ended December 31st, 1886 (in accordance with the arrangements made for the reduction of capital), the actual amount that now stands to the credit of the reserve fund is £3,577.

Eastern Telegraph Co., Limited.—This company announces the payment, on April 14th next, of a dividend of 3s. per share on the preference shares of the company, less income tax, for the quarter ending March 31st, 1887, and an interim dividend of 2s. 6d. per share on the ordinary shares of the company, free of income tax, in respect of profits for the quarter ended December 31st, 1886.

The Eastern Extension, Australasia, and China Telegraph Company, Limited.—This company gives notice that the third drawing for payment of the 5 per cent. debentures (1880 issue)—108 in number—will take place on Wednesday, the 30th inst., at 11.30, at the company's offices, 50, Old Broad Street, E.C.

Great Northern Telegraph Company, Limited.—The offices and station of this company have been removed to 3, St. Helen's Place, E.C.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 18th were £3,067 after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th March are £5,383, as compared with £2,931 in the corresponding period of 1886.

NEW PATENTS—1887.

3943. "Instruments for measuring electric currents." W. H. DOUGLAS. Dated March 16.

3960. "Telephones." A. J. BOULT. (Communicated by A. M. Phelps.) Dated March 16. (*Complete.*)

3990. "Micro-telephonic transmitters." C. CLAMOND. Dated March 16.

3998. "Applying electric light for photographic purposes." F. J. CHARY. Dated March 16.

4010. "Conveying telephone and telegraph wires." A. F. STODDART. Dated March 17.

4015. "Measuring, recording and indicating currents of electricity." T. PARKER, J. H. WOODWARD. Dated March 17.

4027. "Measuring alternating or intermittent electromotive force." R. DICK, R. KENNEDY. Dated March 17. (*Complete.*)

4032. "Holder for brushes of dynamo machines." M. IMMISCH. Dated March 17.

4062. "Porous pots." C. D. BARKER, F. C. HILLS. Dated March 17.

4070. "Combined engines and dynamos." M. H. P. R. SANKEY, P. W. WILLANS. Dated March 17.

4109. "Electrical burglar alarms." R. HADDAN. (Communicated by G. Schleicher.) Dated March 18. (*Complete.*)

4112. "Electric lamps." H. WEBER, R. SCHEFBAUER. Dated March 18.

4114. "Protecting elements of batteries or cells (while in solution)." L. R. DAVIES, M. SHEARER. Dated March 18.

4116. "Electric incandescent lamps; making same." A. F. ST. GEORGE, C. R. BONNE. Dated March 18.

4126. "Electrolysis of certain double chlorides." M. and E. BERNARD. Dated March 18.

4135 "Electro-magnet self-signalling, self-alarm and self-recording thermoscopes; electro-magnetic clock time transmitters." H. J. HAIGHT. Dated March 18. (*Complete.*)

4138. "Safety devices in electric circuits." A. C. COCKBURN. Dated March 19.

4153. "Mechanical telephone." T. H. CHURTON. Dated March 19.

4179. "Making carbon conductors for use in electric glow lamps, &c." T. V. HUGHES. Dated March 19.

4206. "Electric low-water alarm for steam boilers, cylinders, &c." SCHOLES and WHITEHEAD. Dated March 21.

4213. "Electric portable lamp." A. FRIEDLAENDER. Dated March 21. (*Complete.*)

4214. "Indicators, or automatic telegraph apparatus for indicating the direction and speed of motion of marine or other engines, and apparatus for transmitting orders in connection therewith." J. G. ALISON. (Communicated by E. Lambinet.) Dated March 21.

4219. "Accumulators of electricity, or other primary or secondary galvanic batteries." C. DESMAZURES. Dated March 21. (*Complete.*)

4220. "Instruments for measuring electric currents." J. W. KING. Dated March 21.

4225. "Electricity meters; partly applicable to dynamo-electric generators." G. HOOKHAM. Dated March 21.

4240. "Transmitting and receiving apparatus of printing telegraphs." W. S. STELJES. Dated March 21.

4303. "Secondary batteries." W. MAIN. Dated March 22. (*Complete.*)

4311. "Secondary batteries." H. H. LAKE. (Communicated by A. V. Meserole.) Dated March 22. (*Complete*)

4322. "Dynamo-electric machines." J. HOPKINSON, E. HOPKINSON. Dated March 22.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

2632. "Improvements in the treatment and preparation of materials used in electric batteries." J. Y. JOHNSON. (Communicated from L. A. W. Desruelles, of Paris.) Dated February 23. 6d. Claims:—First. Obtaining liquids suitable for use in telegraphic and other like batteries by utilising the residual or waste liquids from bichromate or other like powerful batteries, substantially as described. Second. Mixing the residual or waste liquids from bichromate or like batteries with Kieselguhr or other porous or absorbent and acid proof material, as and for the purpose substantially as described. Third. A battery wherein the residual or waste liquids from bichromate and other like batteries are employed, and the soluble electrodes are protected from corrosion by a coating compounded of grease and mercury, substantially as described.

2691. "An improved electric switch." I. PROBERT. Dated February 24. 6d. The switch comprises two segments of metal attached to and almost surrounding a boss of insulating material. The ends of one segment are at a suitable distance, usually about one-sixteenth of an inch, away from the corresponding ends of the second segment. Around the segments is a ring of insulating material, which can be moved in a circular direction between two non-conducting flanges or shoulders, or a shoulder and a flange. The ring has a piece of metal let into its thickness or otherwise attached to its interior surface which serves to electrically connect the segments, or to sever such connection, according to the direction in which the ring is moved. An electric circuit is completed with the switch by causing the connector or connectors to bridge over the insulating medium between the ends of the segments whereby the segments are put into "series" on one side of the electric circuit. Claim:—An apparatus for turning an electric current on or off a branch or branches of an electric circuit, substantially as described.

2698. "Improvements in electric arc lamps." J. ROPER. Dated February 24. 8d. Claims:—1. In an electric arc lamp, the movable cylinder with fixed piston rod and easily fitting piston, the cylinder being isolated from the carbon holder rod and partly filled with glycerine or other suitable liquid, which acts as a resistance to any sudden fall of the carbon holder, and thereby prevents unsteadiness or jumping of the light, all in the manner substantially as described and represented in the drawings. 2. A modification of claim 1 whereby the inventor makes use of a fixed cylinder and a movable piston and piston rod, thereby effecting the same result.

5341. "Improvements in mechanical telephones." E. P. ALEXANDER. (Communicated from abroad by H. Lamont, of America.) Dated April 16. 8d. In conjunction with the vibrant bar, to which the line wire is secured, there is provided a vibrant receiver which may be of similar material to the said bar, and which is preferably bent in a U or bow-like form, so that the ends thereof can bear with slight elasticity against the ears of the operator when the receiver is distended and applied. The claims are 8 in number.

5878. "Improved automatic electrical switch for controlling the current passing between the generator and secondary batteries, and for cutting lamps and other electrical apparatus in or out of circuit." J. RADCLIFFE. Dated April 30. 8d. The inventor employs a bobbin of fine wire connected as a shunt to the main circuit, provided with a soft iron core pivotted at each end so as to be capable of revolving in the direction of its axis and carrying at one or both ends a tongue, also of soft iron, arranged so as to work between the poles of an electro-magnet, the bobbins of which are wound with thick copper wire or tape of sufficient capacity to carry the main charging current, one end being permanently connected to the tongue and the other to the dynamo. The tongue is provided at its extremity with a contact piece of any suitable metal, and held normally by means of an adjustable spring against a contact spring connected to the dynamo through an adjustable resistance, another contact spring being also connected to the same pole of the dynamo through the accumulators. The resistance is adjusted so as to rather more than balance the counter electromotive force of the accumulators, and as soon as the dynamo is generating sufficient current to deflect the tongue, the resistance coil is cut of circuit and the accumulators cut in, and *vice versâ*.

12656. "Improvements in or relating to batteries." A. J. BOULT. (Communicated from abroad by H. B. COX, of Cincinnati.) Dated October 5. 4d. Claim:—A battery element having its exciting fluid thickened by gelatine to the consistency of jelly or its equivalent so as to admit of fermentation and thereby assist in the action of the exciting fluid.

13459. "An improved apparatus for regulating automatically the intensity of the currents in dynamo-electric machines." H. J. HADDAN. (Communicated from abroad by F. Vivó y Graells, of Spain.) Dated October 21. 11d. Claims:—1. The combination of two symmetrical cones, one of which is set in motion by an engine and transmits the movement to the other which transmits it to the dynamo. The said cones being geared by means of a belt guided automatically upon the whole length of their surfaces, by means of guides or forks fixed in a carrier moving along one or more spindles placed parallel to the axes of the cones, all substantially as set forth. 2. The combination of two electro-magnets actuated either by means of a derived current, or by the main current, or by means of a current produced from any source and which attract in opposite direction a lever gearing with the spindles upon which the carrier travels, all substantially as set forth. 3. The combination of an amperemeter acting as a commutator apparatus, with a pointer adapted to some electric contact between two points placed on either side of the point corresponding to the normal intensity of the current, in order to close the circuit of one or other of the electro-magnets of the carrier, whenever the intensity of the main current increases or decreases, substantially as described. 4. The combination of two racks placed one on each side of the carrier, with the teeth cut symmetrically and in opposite direction in each of the racks with a spring catch attached to the lever and gearing in the teeth of the racks, all substantially as set forth and for the purpose described.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

AN extraordinary general meeting of this society was held on Thursday, March 17th, Prof. W. E. AYRTON, Vice-President, in the chair. The minutes of the last ordinary general meeting having been read and confirmed and the list of new, and proposed new, members announced, the Secretary referred to the great loss which the society had sustained by the death of their librarian, Mr. A. J. Frost.

The adjourned discussion on Mr. FitzGerald's paper was continued.

Prof. G. FORBES drew attention to the fact that in the Union cell the capacity appeared to be greater for a slow than for a quick discharge; a great feature in the battery was its lightness compared with its storage capacity. The nature of the material of which the electrodes was composed was remarkably good mechanically. The plates, which had been in extensive use, appeared to be quite as good as new ones, there being no deterioration apparent. It was noticeable that white sulphating never took place. He considered that very great forward strides had been made by Mr. FitzGerald. There were several features in the cell which deserved notice, viz., the way in which the plates were supported and the way in which they were kept apart by the use of celluloid. Platinum was used for contacts and also mercury cups; he did not consider the latter an objectionable feature; in fact, the mercury was used because it was found to answer the required purpose well. He would like to have more information about the celluloid, as it appeared to be a very useful material. The employment of platinum was the one objection he saw in the cell, as it must be expensive. The results of all the tests showed that a considerable advance had been made. He was puzzled at a peculiarity which he had noticed in the battery; in the ordinary storage cells it was found that when they were being charged they had an E.M.F. of 2¼ volts, but while being discharged this E.M.F. fell at once to 2 volts, consequently there was a loss of

efficiency in the ratio of 2¼ to 2; in Mr. FitzGerald's battery there was no such difference; what the cause of the difference was he was not prepared to say—was it due to the hydrogen sticking to the plate? If it were so, the new plates would appear to depolarise like the plate in a Smee's cell.

Prof. SILVANUS THOMPSON said that he had tried one of Mr. FitzGerald's cells and it had behaved exceedingly well; that is to say, it had not sulphated and no buckling had taken place; there were also no signs of deterioration. He was a little disappointed at the rate of discharge in comparison with the size of the plates; a higher rate would probably be obtained if the metal in connection with the lithanode was of larger area, but inasmuch as platinum was used the cost difficulty would arise. Lithanode itself was not a sufficiently good conductor to enable a large backing to be dispensed with, such as was used in "grid" batteries. He disagreed upon the sulphating question; there are two sulphates, viz., the grey and the white. The Pb SO_4 was easy to oxidise, but if formed in a cell and reduced to Pb O, then this became Pb_2 SO_5 when the battery was idle and choked the cell. Mr. Preece had recommended the use of the hydrometer for testing the charge in the batteries; he could heartily endorse this, but he differed from the figures given, as these must depend upon the bulk of liquid present. If we know the E.M.F. of an accumulator we ought to be able to calculate the chemical action, *i.e.*, the latter ought to correspond to the calculation if correct. There were five formulæ which had been suggested, and the question was, which was correct; the first was as follows:—

$$+ H_2 \mid O - \tfrac{1}{2} Pb O \mid O - \tfrac{1}{2} Pb \mid O$$
$$68000 - 6070 - 25150 = 37200 = \cdot 81 \text{ volts.}$$

The 2nd gave 1·77 volts; the 3rd, which was practically Mr. FitzGerald's, gave ·96 volts; the 4th was the commonly accepted one, and was as follows:—

$$+ Pb \mid O - (H_2 O) + (Pb O \mid SO_3 \mid Aq) - Pb O \mid O) + (H_2 O) + (Pb O \mid SO_3 \mid Aq)$$

the thermal equivalents of which were

$$51060 - 68800 + 24840 - 12140 + 68800 + 24840 = 88600 = 1 \cdot 93 \text{ volts.}$$

This was therefore a fair representation of what happened *finally*, though not at first.

The 5th formula was as follows:—

$$+ Pb O \mid O + Pb \mid O$$
$$52400 + 51060 = 103460 = 2 \cdot 2 \text{ volts}$$

which was therefore the true action. Sulphating takes place in two stages, as shown by Planté's experiment in contradiction to what Dr. Gladstone says.

Mr. SELLON did not consider that storage batteries were still in their infancy as suggested in Mr. FitzGerald's paper. There were not many points in which improvements were possible except as regards care in their manufacture and in their management. Practically no advance had been made in the general principle since the batteries were first brought out. The highest result shown in the tables given by Mr. FitzGerald did not exceed those attained in 1881. The good working of a battery depended greatly upon the uniformity of the electrolyte, and the method of daily replacing plates would not enable this to be attained. He did not think that high capacity and durability could be maintained after a time in the solid peroxide plates, as clogging up will take place, and the unequal distribution of the charge which will ensue will eventually spoil them. The distributed lead of the grid in the ordinary plates played an important part, which was absent in the lithanode. He considered that the local action which was so often spoken of was a mere bugbear. The figures which were given of the various accumulators proved that the E. P. S. cells gave 30 ampères per lb. weight of active material, and under exceptional conditions as high as 47 ampères as against 16 ampères for the lithanode. He believed that four-fifths of the lithanode plate was practically inactive.

Mr. ANDERSEN stated that an examination of the figures proved the comparatively low results obtained from the lithanode plates.

Mr. BERNARD DRAKE thought the question with regard to this new battery from the consumer's point of view was one of first cost and durability. What people wanted to know now-a-days was whether they could obtain a cheaper battery which would give them reliable results in working and entail no trouble. Time alone would show whether the battery before them met these requirements. Mr. Sellon complained that progress in improvements in secondary batteries was slow. If this was so, the reason was that whenever modifications were made it was necessary to wait many months before any idea could be formed as to whether the alteration was an improvement or not. Even then experience had shown that one was almost certain, if guided by any single experiment, to fall into some error ten times worse than the one which was beimg rectified. He thought it impossible to determine a fixed output for each maker's cell, as anyone could increase the capacity at the sacrifice of durability. For instance, with the E.P.S. form it was usual to vary the output between four and six ampère-hours per pound of plate. The figures given by Mr. FitzGerald seemed to include the connections as well as the plates. This, the speaker also thought, was not a fair basis for comparison, as the connections were often made larger than necessary in order to reduce the internal resistance of the whole battery, the resistance of the connections being quite as serious a consideration as the internal resistance of the cell itself. He was glad to see that Mr. FitzGerald agreed with the theory propounded by Mr. Gorham and himself at the meeting of the British Association as to the grid being protected by a dense coating of peroxide. This conclusion was arrived at after a great number of experiments, and he was of opinion that the protecting coat was almost, if not perfectly, dry when a plate was in good condition. If a plate was exhausted, he thought the coating of peroxide became moist, and local action immediately took place. Prof. Forbes had shown a table of some tests with the lithanode plates, in which the capacity of the cells varied considerably, according to the rate of discharge. Had Prof. Forbes taken into consideration in these the recuperative power of the cell? He thought the capacity was not materially affected by the rate of discharge, provided the cell was constantly allowed to recover itself. The proposal to carry the plates backwards and forwards to a charging station was very similar to temporary lighting, with which he had had considerable experience. Although the figures as to cost incurred on any one trial installation would seem to show that this class of work might be undertaken and made to pay its way, yet as the result of a whole season's working with about 25 tons of cells he had found that the price would have to be such as would prohibit any very general use of the system. Mr. Sellon and his engineer had given them comparisons between the E.P.S. and the lithanode plates. These were scarcely to the point, as the whole of the capacity was taken as coming from the active material alone in the E.P.S plates, the weight of the grids being omitted entirely, whereas about a quarter of the total capacity could be obtained from the grids alone, left unpasted. Prof. Thompson's explanation of the action of the battery was both clever and interesting.

Prof. AYRTON agreed that as regards the capacity per rate of discharge, Mr. Drake was correct in his surmise. He would like to ask whether with the lithanode plates the current kept constant, and then eventually suddenly fell off, and whether this was due to fall of E.M.F. or increase of resistance. He objected to the use of the expression horse-power-hour capacity, as it was like speaking of living at the rate of £100,000 a year for a minute when one buys a watch. What was really required was the total number of watts which could be obtained for £1, and not for 1 lb., as weight does not matter, except in the case of tramcars. Mr. Drake's statement that carting about does not pay on a large scale probably meant that there were not enough people willing to pay so as to make it worth a system being carried out on a large scale. He thought it very advisable for some definite names to be given to the plates of accumulators, as the names anode and cathode are not very happy terms.

Mr. FITZGERALD, in replying, said that he wished first to correct an error which had been made at the end of his paper, where the weight of the boxes should be stated to be 20 lbs. and not 10 lbs. He and Dr. Gladstone were substantially in agreement, as he had misunderstood the terms used by him; he would accept Gladstone and Tribe's formula except as regards the initial action. He appreciated Mr. Preece's remarks as regards the value of the hydrometer; such experiments threw considerable light upon the question of the amount of sulphuric acid combining with the lead plates. As regards the suggestion that experience would prove that the formation of lead sulphate was a necessity, his own experiments proved quite the reverse; he had charged and discharged one of his cells 80 times, and had never seen any formation of lead sulphate. The rate of discharge of the lithanode elements could be varied within very wide limits. He did not believe that it could be proved that either the capacity or rate of discharge of the lithanode elements was less than that of other batteries; it was exceedingly difficult to take in all that had been said upon this point, and therefore he could not argue the question out on the spur of the moment.

The meeting then adjourned.

Mr. SWINBURNE (Communication): I was sorry to be too ill to attend the discussion on Mr. FitzGerald's paper. If Mr. FitzGerald's lithanode is half as good as it looks, it is certainly the geatest advance in secondary batteries since the days of Planté. Many seem to have tried to make plates of peroxide of lead so as to avoid local action, but they have not been commercially successful. The late Mr. Tribe started the idea, but his peroxide seems to have been too soft. The writer tried to make peroxide by electrolysis of an alkaline solution, but his peroxide on the other hand was too dense and impervious. Mr. FitzGerald seems to have solved the problem, and to have got over the chief fault, that is if lithanode is itself durable. Mr. FitzGerald does not say how he makes lithanode, but it is presumably a mixture of lead sulphate and peroxide, the sulphate being the binding material. If the lead sulphate is the only binding material it seems probable that it will be eventually turned into peroxide if the cell is overcharged, as in practice all cells are, when the plate will fall to pieces. The material must be either impervious or pervious, or it may be formed of pieces of impervious material with chinks and crannies so as to expose a large surface. Thus if the particles were examined under the microscope one might expect to find lithanode made up of innumerable little lumps agglomerated together with interstices between, so that there is an enormous surface exposed. The material might thus be almost impervious, and the thin film being converted into peroxide would give the plate enough output. The peroxide made from alkaline solutions is almost impervious, but on discharging a very thin film of sulphate is formed; it seems, therefore, as if the peroxide must always be to some small extent pervious. The sulphate in the lithanode cannot be exposed to the acid at any points, for if it were, it would be converted on charging or overcharging into peroxide. The sulphate must therefore always be protected by

the peroxide, just as the lead in an ordinary plate is; the cementing material on which the whole life of the plate depends, is therefore protected from the acid in just the same way as the lead is in an ordinary battery. It would thus seem that there is no reason to suppose that lithanode will last any longer than an ordinary lead plate. This always assumes that lithanode is merely lead peroxide cemented together by lead sulphate, and I hope my reasoning or my premises may be wrong. There is, however, one fundamental difference, that is, that lithanode can only be injured by overcharging, while the prejudical action in lead plates goes on practically always.

Mr. FitzGerald's theory that the lower electromotive force is due to the formation of a sesquioxide of lead seems improbable. Some time ago I objected to this theory, that even if such a compound can be formed, it cannot be formed in the presence of sulphuric acid. It seems much more likely that the fall in electromotive force is due to the acid in the interstices being used up, so that there is only very weak acid or water available. Perhaps basic salts are formed; this would account for the fall in electromotive force if they were formed in one plate or both.

The failure of cells is more often due to the reduced plate than is generally supposed. Before drawing any conclusions, it is always advisable to test the plates with proof plates, as described in my paper a week or two ago. I would suggest that the experiment with the platinum plates, one having peroxide and the other peroxide and sulphate mixed, does not definitely prove anything. The sulphate may have merely insulated the peroxide in the plate. It also seems strange that such cells could give anything like two volts.

Dr. Gladstone has to some extent misunderstood me. I certainly did not refer to him when I spoke of chemists forgetting their chemistry when working with electricity, as is evident from the context, more especially as it was Messrs. Gladstone and Tribe who brought people to their senses and reminded them that lead oxides did not remain in the presence of sulphuric acid. Dr. Gladstone goes on to say, however, that to view lead sulphate as containing lead oxide was very antiquated chemistry. I do not think he can have understood the drift of what I said. The most modern chemists certainly often write such a compound of lead as the sulphate Pb O SO_3, as if it were a compound of Pb O and SO_3. Though Dr. Gladstone may not write Pb O SO_3, surely he writes the reaction as if the peroxide and the spongy lead were first converted into lead oxide, and the lead oxide were then acted on by the acid to form sulphate with the elimination of water. What I tried to show was, that if such an action took place, the only energy available as electrical energy would be that due to the algebraical sum of the energies of the formation of lead oxide; but energy equal to that due to the formation of lead sulphate from lead oxide would be converted into heat, and would not be available in the outer circuit. If the lead and lead peroxide were converted into Pb O, and a secondary action with the electrolyte then took place, one would expect to get the same electromotive force from lead cells whatever the electrolyte. Of course I am aware that the energy of combination does not fully account for the electromotive force of cells, and it seems probable that there are what might be called Peltier effects of enormous magnitude. For instance, if water is decomposed, and with platinum plates, and also with a zinc cathode and peroxide anode, the electromotive forces required are very different, while the chemical and physical changes are the same in each case. Dr. Gladstone lays stress on the value of lead sulphate as it prevents local action in a cell while standing, and points out that its formation is therefore necessary to the life of the cell, but he does not say that the high electromotive force of a sulphuric acid lead cell is due to the strong affinities of the electrolyte and coatings.

Mr. Preece mentions that he has tried sodium carbonate to remove lead sulphate as proposed by Mr. Barber Starkey; it surely would be better not to wait till a lot of sulphate is formed and then reduce it, but to put a little sodium sulphate, not carbonate, in the cell at first, to prevent the accumulation of sulphate, as proposed in my paper. It cannot be a good plan to put much sodium sulphate in a cell, as creeping may result.

Physical Society, March 12th, 1887.

Prof. CAREY FOSTER, Vice-President, in the Chair.

Mr. SHELFORD BIDWELL described some experiments which seem to show that the electrical resistance of suspended copper and iron wires alters with the direction of the testing current. The apparatus used consisted of a metre bridge with coils of 100 ohms in the gaps adjoining the standard wire, the other two arms being two suspended wires united at the top, to which point one terminal of the galvanometer was joined. A commutator placed in the battery circuit served to reverse the testing current.

When a wire is suspended vertically the stress increases from below upwards, and the author believes the observed effects due to the absorption of heat by the current as it passes from a stretched towards an unstretched part of a copper wire, and the evolution of heat when it passes from an unstretched towards a stretched part. As the apparatus was arranged, the current passed up one wire and down the other, heating the one and cooling the other, thus disturbing the position of balance. If iron wires be used the heating and cooling effects are reversed.

Prof. S. P. THOMPSON suggested loading the wires at different points, in order to vary the stress without using such long wires, and

Mr. C. V. BOYS thought still shorter wires could be used by joining the ends to a revolving spindle and stretching them by centrifugal force.

"On a Lecture Experiment in Self-Induction," by Mr. SHELFORD BIDWELL. A telephone is placed in series with the secondary coil of an induction coil and another coil, when self-induction can be varied by inserting a core of iron wires, or another coil, or both. The effect of introducing the iron core is very marked, reducing the sound enormously. If a coil of wire containing an iron core be inserted the effect of short-circuiting the coil increases the sound in the telephone.

The same author also described and showed an experiment due to Dr. Fleming, in which a disc of copper inclined at an angle of 45° to the axis of a coil of wire and suspended bifilarly, is deflected by passing an undulatory current round the coil.

In explanation of the former experiment, Dr. FLEMING wrote down the formula for the effective resistance and self-induction of a circuit near another closed circuit, which show that the former is greater and the latter less for undulatory than for steady currents. He had not arrived at any satisfactory explanation of the deflection of the copper disc.

Prof. AYRTON exhibited a tuning fork worked electrically, in which the pitch could be varied by altering the self-induction of the circuit, or by varying the position of the make-and-break screw.

Mr. C. V. BOYS referred to his experiments, published in 1884, on the impulse given to metal discs suspended in a magnetic field, whose strength is suddenly changed, as being of a similar character to that described by Mr. Bidwell, and suggested the use of aluminium instead of copper in future experiments, owing to its conductivity for the same weight being greater.

Prof. THOMPSON said he had recently used a similar apparatus to that described by Mr. Bidwell as an illustration of the effect of self-induction, and pointed out the uses of self and mutual induction in multiplex telegraphy and telephony.

As an explanation of the deflection of the copper discs by alternating currents, Prof. FOSTER thought it possibly due to its initial position being that of maximum sensibility, and, therefore, each impulse had less effect than the preceding one.

Mr. W. M. MORDEY mentioned a simple arrangement for varying self-induction used by Mr. Ferranti to control the power of incandescent lamps worked by alternating currents; and

Prof. AYRTON described a closed magnetic circuit of great self-induction, used to protect voltmeters on the telpher line at Glynde, from disastrous inductive effects produced by breaking the locomotive circuit.

Referring to tuning forks Mr. BOSANQUET thought some self-induction was necessary in order that the current should act to the best advantage, in attracting the prongs at the proper instant.

Further remarks were made by Mr. BOYS and Prof. PERRY.

On a lecture experiment to show that capacity varies inversely as the thickness of the dielectric, by Profs. W. E. AYRTON and JOHN PERRY. The authors consider it easy for students to see that, other things remaining constant, capacity is proportional to area. Taking this as proved, a condenser is arranged, such that the area, A, of the insulated inner coating varies as the thickness, t, of the dielectric, and the potential difference between the coatings is found by experiment to be constant. Then, since capacity $= \frac{\text{quantity}}{\text{potential}}$, and both the latter being constant, therefore the capacity of the condenser is constant. But by the construction of the apparatus $\frac{A}{t}$ is constant, and it is assumed that capacity varies as A, therefore capacity must vary inversely as t, Q.E.D.

"Note on Magnetic Resistance," by the same authors. Two iron rings about six inches diameter made from the same bar of best Swedish iron about half-inch diameter, were wound with insulated wire in two halves, so that a current could be sent round either or both halves, and the resulting induction measured by the throw of a ballistic galvanometer placed in series with a few convolutions of wire wound round the outside of the main winding. One of the rings was continuous, and the other had a small air space of about ·8 mm. in a plane perpendicular to that of the ring and passing through its axis, as if the ring had been cut by a saw. The primary object of the experiments which were made by Messrs. Aldworth, Dykes, Lamb, Robertson and Zingler of the Central Institution, was to determine whether there was any appreciable "surface magnetic resistance." The results do not show any such resistance, and the relative resistance of air and iron as calculated from the unsaturated parts are about as 1,200 to 1, a number agreeing fairly well with those obtained by other experimenters. From this the authors conclude that for small distances, magnetic resistance of air is proportional to its length. When the magnetising current was passed round the one half of the divided ring on which the test coil was wound, a greater induction could be obtained than by any other way of magnetising, and this the authors do not attempt to explain.

Mr. BOSANQUET said he had always found greater induction obtainable in the middle of bar electro-magnets or open magnetic circuits than could be produced in closed magnetic circuits, and thought the above observations confirmed his own results.

A discussion followed, in which Mr. C. V. BOYS, Mr. W. M. MORDEY, Mr. BOSANQUET and Prof. PERRY took part.

On account of the late hour, the reading of a Note on Dynamo Machines and Motors, by Profs. Ayrton and Perry, was postponed till the next meeting.

CORRESPONDENCE.

The Broomhill Installation.

I will give your correspondent, "B.P.," the information he asks for. The wire is I.R. covered and tarred tape over. The wire itself is copper tinned to preserve it from the action of the I.R. There is a return lead, and the whole system is insulated. The leads, large and small, situated in the cellar are placed in wood grooved to receive them, only one wire in a groove, and then covered with a wooden strip. The wood is painted all over, inside and out with two coats, and in some cases tarred. The breakages occurred in both leads indiscriminately. I take this opportunity of correcting the "editorial note" to my last letter. The editor and myself both came to the same conclusion: he says the fault lies in the method of tinning, I say in the manufacture; still he will not allow the two to mean the same thing. Again, he appears to fall into the error of supposing that the wires cannot be damp and have no leakage to be worth speaking of. This is quite possible if the wires are well insulated from the walls, and in a tunnel where the wires run and are always wet there is no perceptible leakage, but if one end of a wire is held to one lead and one to the wall, the leakage becomes dangerous.

David Salomons.

March 19th, 1887.

Kapp's Formula.

The American critic on Mr. Gisbert Kapp's formula for the total average E.MF. induced in an armature of the ordinary Gramme type, has not taken into consideration that the E.M.F. induced is directed from one neutral point towards the other by two paths, therefore there are only $\frac{N}{2}t$ turns of wire in series at one time; this halves the American's equation, and reduces it to that he has taken exception to.

James Raeburn, jun.

March 21st, 1887.

Voltage of an Incandescent Lamp.

Given a lamp, without mark of any kind, how can it be ascertained at what E.M.F. it is intended to be run? The measured cold resistance may be some guide, taken in connection with the apparent length and diameter (or extent of surface if not cylindrical) of the filament. Is there any more scientific way than to try the lamp with a gradually increasing E.M.F., and stop the increase when the outline of the filament begins to be obscured by its own brilliance?

Ajax.

Sir Charles Bright's Address.

Your correspondent, "Manchester," who for some cause appears to be ashamed of giving his name, has properly apologised for one gross misstatement (in his letter to you of January 28th) regarding the Persian Gulf cable.

He ought now to take back one of his misstatements in his renewed attack in your current number. He says that the underground wires of the Magnetic Company were laid "*just* before" the Electric Company's lines, which were first opened to the public in 1854. The Magnetic Company's first underground lines were opened to the public for messages in 1851; the Electric Company copying their example three years afterwards.

I need not enter further upon this anonymous letter, as it is throughout a repetition of exaggeration, evidently based upon utter ignorance of facts, and in no way affecting my address. There seems to be some personal illfeeling underlying your disguised correspondent's letters, for which I care nothing—"*aquila non capit muscas.*"

Charles T. Bright.

March 21st, 1887.

Use of Hydrometers in working Secondary Batteries.

In Mr. A. Reckenzaun's paper which appeared in your last issue, mention is made of my employing in 1884 a hydrometer in conjunction with a piece of silk working on a pulley for the purpose he describes. If he saw such an arrangement at the period mentioned it must have been a relic of a rough and ready contrivance of a very much earlier date which I had used to indicate with approximate accuracy the condition of the cell as to charging and discharging by means of a pivoted finger of aluminium actuated by the rise and fall of the hydrometer, and thus moved backwards and forwards in front of a semi-circular piece of cardboard marked with divisions and figures. It was a simple and crude contrivance, which anyone with a little gumption could have arranged, but in those early days I found it most useful. The employment of a hydrometer in every cell has always been advocated by me as most desirable, and I was possibly the first, somewhere about the end of 1882, to draw attention to its advantages, not only for readily arriving at the condition of each cell, but for enabling the merest novice to know when to stop charging or discharging, and thus to prolong the life of the plates by arresting the disintegration (and also the waste of energy) in the one case and injurious sulphating in the other. In one of my specifications of 1883, No. 1,644, I fully explained that such an instrument could be utilised "for indicating by its rise and fall the condition of the batteries at any time, *i.e.*, the extent to which they have been charged or the amount of energy remaining in them" as also for "indicating and registering the amount of current put in or taken out of the cells by means of a suitable device." I, of course, made no claim to these simple and natural arrangements, but I fully described and illustrated what was the subject of my patent, viz., "a ready means of automatically cutting out and putting into the charging circuit secondary battery cells," a means which I have found to act readily and accurately. My claim reads:—"The use in combination with secondary batteries or electrical accumulators of an acidometer, float, ball, or vacuum box or the like, which is caused to rise and fall in accordance with alterations of density or specific gravity in the electrolyte or fluid of the said batteries, and to actuate contacts or mechanism to complete the circuit to cause the cutting off of the charging current or for putting the charging current in circuit; one or both of them substantially as hereinbefore described."

The use of acidometers or hydrometers has not been sufficiently attended to, but I hope after the remarks lately made by Mr. Reckenzaun in his article and by Mr. Preece in the late discussion on Mr. FitzGerald's paper that more attention will be given to their use, as they are most valuable aids to the working and regulating of secondary batteries, and it is with this object that I now write to you.

To ensure greater accuracy in their use, and to obviate one little difficulty suggested by Mr. Reckenzaun, the electrolyte in each cell should be blown up or agitated for a few seconds occasionally with a small India-rubber hand ball-valve and vulcanite or glass tube. I have used one for many years, making it a rule that each cell should be so "blown" at least once a week, and I have found great benefit and regularity resulting from its use, for without it the sulphuric acid is apt to liquate to the bottom of the cell, bringing about greater density and consequent irregularity of work and wear between the upper and lower portions of the plates, unless in cases where habitual overcharging (causing disturbance of the liquid) is indulged in, which I need hardly say is not desirable.

John S. Sellon.